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Mercurialis.

physician, born at Forli in 1530, where he first practised; but afterwards was professor of medicine successively at Padua, Bologna, and Pisa. His writings in physic are very numerous; besides giving an edition of Hippocrates in Greek and Latin, with notes, which, however, did not answer the expectations of the learned. He died in 1606; and in 1644 some select pieces of his were published at Venice in one volume folio.

MERCURIALIS, MERCURY, in botany: A genus of the enneandria order, belonging to the diœcia class of plants; and in the natural method ranking under the 38th order, *Tricocca*. The calyx of the male is tripartite; there is no corolla, but nine or twelve stamina; the antheræ globular and twin. The female calyx is tripartite; there is no corolla, but two styles; the capsule bicocous, bilocular, and monospermous. There are three species. 1. The annua, or French mercury, with spiked flowers, male and female. This is an annual plant, with a branching stalk about a foot high, garnished with spear-shaped leaves of a pale or yellowish green colour. The male plants have spikes of herbaceous flowers growing on the top of the stalks: these fall off soon; but the female plants, which have testiculated flowers proceeding from the side of the stalks, are succeeded by seeds, which, if permitted to scatter, will produce plenty of plants of both sexes. 2. The perennis mountain, or dog's mercury, with spiked and testiculated flowers, grows under hedges and in woods in many parts of Britain. This has a perennial root, which creeps in the ground; the stalks are single, and without branches, rising 10 or 12 inches high, garnished with rough leaves, placed by pairs at each joint, of a dark green colour, indented on their edges: these have their male flowers growing in spikes, upon different plants from those which produce seeds. 3. The tomentosa, or shrubby hairy mercury, is a native of the south of France, Spain, and Italy. It has a shrubby branching stalk, growing a foot and an half high, garnished with oval leaves placed by pairs, and covered with a white down on both sides. The male flowers grow in short spikes from the side of the stalks upon different plants from the first. All the species are easily propagated by seeds, and are apt to become troublesome weeds where they have once got a footing.

Properties. The perennis, according to Mr Lightfoot, is of a soporific deleterious nature, noxious both to man and beast. There are instances of those who have eaten it by mistake instead of chenopodium, bonus Henricus, or English mercury, and have thereby slept their last. In the isle of Skye, it is called *lus-glen-bracadale*; and an infusion of it is sometimes taken to bring on a salivation; but our author knows not how the experiment answers. Tournefort informs us, that the French make a syrup of the juice of the annua, two ounces of which is given as a purge; and that they use it in pessaries and clysters, mixing one quantity of honey to one and a half of the juice. Mr Withering differs greatly from Lightfoot concerning the qualities of the perennis. "This plant (says he), dressed like spinach, is very good eating early in the spring, and is frequently gathered for that purpose; but it is said to be hurtful to sheep. Mr Ray relates the case of a man, his wife, and three children, who expe-

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rienced highly deleterious effects from eating it fried with bacon; but this was probably when the spring was more advanced, and the plant become acrimonious. Steeped in water, it affords a fine deep blue colour. Sheep and goats eat it; cows and horses refuse it.

MERCURIFICATION, in metallurgic chemistry, the obtaining the mercury from metallic minerals in its fluid form. For the effecting this, those who have been engaged in these researches have proposed three methods. The first is by means of a certain mercury, so prepared as to have a dissolving power, by which it could take up the mercuries of metals in the same manner as water dissolves salt from ashes. The second is by means of certain regenerating salts, such as sal ammoniac, which are to detain the more earthy parts of metals, and leave their mercuries separate or separable from them by sublimation or otherwise; and the third method is by means of a large lens or burning-glass, in the focus whereof, if any metal be applied, its mercurial part is said to separate and go off in fume, which when collected and condensed, appears to be running mercury.

The first of these methods would be very easy if the proper mercury were to be readily produced; the second is extremely laborious, and requires much patience and reiteration. But the third seems easy enough, and practicable to advantage, when a glass of three or four feet in diameter is at hand, the sky serene, and the sun shines strong.

For other processes, the reader may consult Junker's *Conspectus Chæmiæ*. But these mercurified metals, or their mercurial principle rendered sensible, are a kind of philosophical mercury, which, although they resemble ordinary mercury, are nevertheless said by persons exercised in such studies, to differ from it considerably, by having a greater specific gravity, by more effectually penetrating and dissolving metals, by a stronger adhesion to these, and by a less volatility.

MERCURY, in natural history. See **CHEMISTRY**, *Index*. See also **METALLURGY**, and **QUICKSILVER**.

The use of mercury in medicine seems to have been little known before the 15th century. The ancients looked upon it as a corrosive poison, tho' of itself perfectly void of acrimony, taste, and smell: there are examples of its having been lodged for years in cavities both in bones and fleshy parts, without its having injured or affected them. Taken into the body in its crude state, and undivided, it passes through the intestines unchanged, and has not been found to produce any considerable effect. It has indeed been recommended in asthma and disorders of the lungs; but the virtues attributed to it in these cases have not been warranted by experience.

Notwithstanding the mildness and inactivity of crude quicksilver undivided; yet, when resolved by fire into the form of fume, or otherwise divided into very minute particles, and prevented from re-uniting by the interposition of proper substances, or combined with mineral acids, it has very powerful effects; affording the most violent poisons, and the most excellent remedies with which we are acquainted.

The mercurial preparations, either given internally or introduced into a habit by external application,

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Mercurification, Mercury.

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REGIA
MONACENSIS.

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Mercury. seem to forward circulation through even the minutest and most remote vessels of the body; and may be so managed as to promote excretion through all the emunctories. Hence their common use in inveterate chronic disorders, and obstinate obstructions of the excretory glands; in scrophulous and cutaneous diseases; and in the venereal lues. If their power be not restrained to certain emunctories, they tend chiefly to affect the mouth; and occasion a plentiful evacuation from the salival glands.

The salutary effects of mercurials do not depend on the quantity of sensible evacuation. This medicine may be gradually introduced into the habit, so as, without occasioning any remarkable discharge, to be productive of very happy effects. To answer this purpose, it should be given in very small doses, in conjunction with such substances as determine its action to the kidneys or the pores of the skin. By this method, inveterate cutaneous and venereal distempers have been cured, without any other sensible excretion than a gentle increase of perspiration or urine. Where there are ulcers in any part, they discharge for some time a very fetid matter, the quantity of which becomes gradually less, and at length the ulcer kindly heals. If the mercury should at any time, from cold, or the like, affect the mouth, it may be restrained by omitting a dose, and by warmth, or suitable medicines promoting the perspiration.

Cooling purgatives are also often employed with advantage; but perhaps the most effectual means of giving with safety a sudden check to a mercurial salivation, is by the application of a large blister to the back.

Mercury, as used in medicine, has been employed in a vast variety of different forms. But there is reason to believe, that every useful purpose to be answered by mercury may be obtained from a very few. The mercurial preparations in general, with a view to their use both externally and internally, may be divided into two great classes, the mild and the acrid. Almost every purpose to be answered by the former, may be accomplished by the unguentum hydrargyri and pilulæ ex hydrargyro of the London and Edinburgh pharmacopœias; while most of the effects to be obtained from the latter may be derived from the proper use of those preparations, hitherto generally known under the title of *calomel*, and *corrosive sublimate mercury*.

The marks of pure mercury are, its globules not losing their spherical figure when poured on wood; its not communicating a tinge to water, or sweetness to vinegar, when rubbed with them; its evaporating entirely in an iron spoon over the fire; and its having a shining appearance without any pellicle on its surface. Mercury is best purified by distillation in an iron pot, with a long neck bent and immersed in vinegar.

Quicksilver has sometimes been used in its pure metallic state, with the view of removing obstructions in the alimentary canal, from an idea that it would operate by its weight. But it is seldom attended with a good effect, and sometimes it must do harm.

Whole volumes have been written respecting its operation and use in different diseases, and particularly in venereal affections. Some refer its operation to an evacuant power, others to its operating as a peculiar

stimulus, and a third set to its possessing a power of destroying or neutralizing the venereal virus. Of these opinions, the latter is the most generally received, and perhaps the best founded. But for a more full view of the controversy, we may refer our readers to late publications on the venereal disease, and on mercury, by Mr John Hunter, Dr Schwediauer, and Dr Duncan.

In virulent gonorrhœa, it is doubted whether mercury be necessary. This disease is commonly treated like any similar inflammation: and the chief things attended to are cleanliness of the parts, a regular belly, and an abstinence from every thing stimulant in food, drink, &c. An injection of oil with calomel, or white precipitate, is much used, and some prefer a watery solution of opium. The more active injections have sometimes very disagreeable consequences.

When the constitution is affected, which is known by ulcers on the glands, buboes, ulcers in the mouth or throat, copper-coloured spots and ulcers on the surface, nodes, &c. mercury is thrown into the body either by friction or by the mouth. The general rule is, to keep up a slight foretaste of the gums for some short time after the symptoms disappear; at the same time it is to be remembered, that mercury sometimes continues gleets, and induces ulcers, that are difficultly distinguished from venereal ones; and that these last only yield to warm bathing, diaphoretic diluents, opiates, country air, and milk diet. Corrosive sublimate is sometimes used, as more speedily arresting disagreeable, spreading, or dangerous ulcers; but the completion of the cure should always be trusted to the mild preparations alone. Mercury is also used in rabies canina, in worms, in hydrocephalus internus, in tetanus, and is by some considered as an antidote to the variolous matter.

MERCURY, in the heathen mythology. See HERMES.

Most of the actions and inventions of the Egyptian Mercury have likewise been ascribed to the Grecian, who was said to be the son of Jupiter and Maia, the daughter of Atlas. No one of all the heathen divinities had so many functions allotted to him as this god: he had constant employment both day and night, having been the common minister and messenger of the whole Pantheon; particularly of his father Jupiter, whom he served with indefatigable labour, and sometimes indeed in a capacity of no very honourable kind. Lucian is very pleasant upon the multitude of his avocations; and, according to the confession of the emperor Julian, Mercury was no hero, but rather one who inspired mankind with wit, learning, and the ornamental arts of life, than with courage. The pious emperor, however, omits some of his attributes; for this god was not only the patron of trade, but also of theft and fraud.

Amphion is said, by Pausanias, to have been the first that erected an altar to this god; who, in return, invested him with such extraordinary powers of music (and masonry), as to enable him to fortify the city of Thebes in Bœotia, by the mere sound of his lyre.

Horace gives us the best part of his character.

Thou god of wit, from Atlas sprung,
Who by persuasive pow'r of tongue,

And

Mercury.

And graceful exercise, refin'd
The savage race of human kind,
Hail! winged messenger of Jove,
And all th' immortal pow'rs above.
Sweet parent of the bending lyre,
Thy praise shall all its sounds inspire.

Artful and cunning to conceal
Whate'er in sportive theft you steal,
When from the god who gilds the pole,
E'en yet a boy, his herds you stole;
With angry voice the threat'ning pow'r
Bade thee thy fraudulent prey restore;
But of his quiver too beguil'd,
Pleas'd with the theft, Apollo smil'd.

You were the wealthy Priam's guide,
When safe from Agamemnon's pride,
Through hostile camps, which round him spread
Their watchful fires, his way he sped.
Unspotted spirits you consign
To blissful seats and joys divine;
And, pow'rful, with thy golden wand,
The light, unbodied crowd command;
Thus grateful does thy office prove
To gods below, and gods above. *Francis.*

This ode contains the substance of a very long hymn to Mercury, attributed to Homer. Almost all the ancient poets relate the manner in which the Grecian Mercury discovered the lyre; and tell us that it was an instrument with seven strings; a circumstance which makes it essentially different from that said to have been invented by the Egyptian Mercury, which had but three. However, there have been many claimants besides Mercury to the seven-stringed lyre. See *LYRE*.

His most magnificent temple was on mount Cylene, in Arcadia. He is described by the poets as a fair beardless youth, with flaxen hair, lively blue eyes, and a smiling countenance. He has wings fixed to his cap and sandals, and holds the caduceus (or staff surrounded with serpents with two wings on the top) in his hand; and is frequently represented with a purse, to show that he was the god of gain. The animals sacred to him, were the dog, the goat, and the cock. In all the sacrifices offered to him, the tongues of the victims were burnt; and those who escaped imminent danger sacrificed to him a calf with milk and honey.

MERCURY, ☿ in astronomy. See *ASTRONOMY*, *Index*.

This planet is brightest between his elongations and superior conjunction, very near to which last he can generally be seen. He becomes invisible soon after he has found his elongation, going towards his inferior conjunction; and becomes visible again a few days before his next elongation. The brightness of this planet alters sometimes very considerably in 24 hours. It has been observed when less than three degrees distant from the sun, and may, perhaps, sometimes be seen even in conjunction with it.

Mercury and Venus appear brightest and most beautiful in the opposite parts of their orbits: the first, between his elongations and superior conjunction; and the other, between her elongation and inferior conjunction. Therefore, Venus is seen in great perfection as a cre-

scint, particularly in her inferior conjunction, whilst Mercury is seldom seen in such perfect phases. Mercury should be always observed on or near the meridian. When farthest from the sun, he always appears with a very faint light; and when he has a great south declination, or the atmosphere is not perfectly clear, he seldom can be seen in those parts of his orbit, where he only begins to recover his brightness, or where it is much diminished. He has frequently been seen on the meridian even with a small telescope and small power; and it appears from the above statement that he may be obscured in a clear day rather more than half his orbit, or near one hundred and fourscore days in the year.

MERCURY, in heraldry, a term used in blazoning by planets, for the purple colour used in the arms of sovereign princes.

MERCY, a virtue that inspires us with compassion for our brethren, and which inclines us to give them assistance in their necessities. Mercy is also taken for those favours and benefits that we receive either from God or man, particularly in the way of forgiveness of injuries or of debts. Nothing can be more beautiful than the description of mercy given us by Shakespear, in the pleading between Portia and the Jew:

Por. Then must the Jew be merciful.

Shy. On what compulsion must I? tell me that.

Por. The quality of mercy is not strain'd;
It droppeth as the gentle rain from heav'n
Upon the place beneath. It is twice blest:
It blesseth him that gives, and him that takes.
'Tis mightiest in the mightiest; it becomes
The throned monarch better than his crown:
The sceptre shows the force of temporal power,
The attribute to awe and majesty,
Wherein doth sit the dread and fear of kings;
But mercy is above this scepter'd sway,
It is enthroned in the hearts of kings;
It is an attribute to God himself,
And earthly power doth then show likest God's,
When mercy seasons justice. Therefore, Jew,
Though justice be thy plea, consider this,
That in the course of justice none of us
Should see salvation. We do pray for mercy;
And that same prayer doth teach us all to render
The deeds of mercy. *Merchant of Venice*, act iv.

MERCY-SEAT, or PROPITIATORY, in Jewish antiquity, the covering of the ark of the covenant.—The Hebrew name of this cover, which we translate mercy-seat, is *Capporeth* (Exod. xxv. 17. 22.), from *Cappor*, which signifies *to cover, to shut up, to expiate, to pay*. This cover was of gold, and at its two ends were fixed the two cherubims of the same metal, which by their wings extended forwards, seemed to form a throne for the majesty of God, who in scripture is represented to us as sitting between the cherubims, and the ark itself was as it were his footstool. It was from hence that God gave his oracles to Moses, or to the high priest that consulted him, (Exod. xxv. 22. Numb. vii. 89.)

MERETRIX, among the Roman, differed from the *prostituta*. The *prostituta* were common courtezans, with bills over their doors, signifying their profession,

Mercury

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Meretrix.

Merganser, and were ready at all times to entertain customers; whereas the *meretrices* entertained none but at night.—
 The *meretrices* differed in their dress from the *matrons*; the former wore the *toga* and short *tunics*, like those of the men: the latter wore the *palla* and the *stola* of such a length as to reach to their feet.

MERGANSER. See MERGUS.

MERGUS, in ornithology, a genus of birds of the order of anseres; distinguished by having the beak of a cylindrical figure, and hooked at the extremities, and its denticulations of a subulated form.

Plate
CCXCIV.

1. The cucullatus, or crested diver of Catesby, has a globular crest, white on each side; and the body is brown above and white below. This elegant species inhabits North America. It appears at Hudson's Bay the end of May, and builds close to the lakes.—The nest is composed of grass, lined with feathers from the breast; the number of eggs from four to six. The young are yellow, and are fit to fly in July.—They all depart from thence in autumn. They appear at New York, and other parts as low as Virginia and Carolina, in November, where they frequent fresh-waters. They return to the north in March; and are called at Hudson's Bay *Omiska sheep*.

2. The merganser, or goosander, weighs four pounds: its length is two feet four inches; the breadth three feet four. The bill is three inches long, narrow, and finely toothed or serrated; the colour of that and of the irides is red. The *dun-diver*, or female, is less than the male: the head and upper part of the neck is ferruginous; the throat white: the feathers on the hind part are long, and form a pendent crest: the back, the coverts of the wings, and the tail, are of a deep ash-colour: the greater quill-feathers are black, the lesser white; the breast and middle of the belly are white, tinged with yellow. The goosander seems to prefer the more northern situations to those of the south, not being seen in the last except in very severe seasons. It continues the whole year in the Orkneys; and has been shot in the Hebrides in summer. It is common on the continent of Europe and Asia, but most so towards the north. It is found also in Iceland and Greenland, and breeds there, retiring southward in winter, at which time it is found about the lake Baikal. It is frequent in America; inhabits the province of New York in winter; retires from thence in April, probably to Hudson's Bay; and, if it be the bird called a *Fisherman-duck*, found also in Carolina.

3. The ferrator, or red-breasted merganser, weighs about two pounds: the length is one foot nine inches, the breadth two feet seven; the bill is three inches long; the lower mandible red; the upper dusky; the irides a purplish red: head and throat a fine changeable black and green: on the former a long pendent crest of the same colour; the tail short and brown; the legs orange-coloured. The head and upper part of the female are of a deep rust-colour, and the tail ash-coloured. These birds are most frequent in the northern parts of Great Britain. They are observed to breed on Loch Mari, in the county of Ross, and in the isle of Islay. The species is common in most parts of the north of Europe, on the continent; and as high as Iceland, where it is called *Vatus-ond*: also in the Russian dominions, about the great rivers of Si-

beria, and the lake Baikal. It is likewise frequent in Greenland in the summer, where it breeds on the shores. The eggs are like those of a wild duck, but smaller and whiter. It dives well, and is very active in the water; but the Greenlanders often take it by darts thrown at it, especially in August, being the time when it is in moult. It is frequent in Newfoundland, and often appears at Hudson's Bay in large flocks, but is observed to be of a larger size there than in Europe. They generally come in pairs the beginning of June, as soon as the ice breaks up; make the nest soon after their arrival, chiefly on dry spots of ground in the islands, and lay from eight to thirteen white eggs, the size of those of a duck: the nest made of withered grass, and lined with the down of the breast. The young are of a dirty brown, like young goslings. They all depart south in October to the lakes, where they may have open water. They are known at Hudson's Bay by the name of *As-sick*.

4. The albellus, or smew, weighs about 34 ounces: the length 18 inches, the breadth 26; the bill is near two inches long, and of a lead colour; the head is adorned with a long crest, white above and black beneath: the head, neck, and whole under part of the body, are of a pure white; the tail is of a deep ash-colour, the legs a bluish grey. The female, or *lough-diver*, is less than the male: the back, the scapulars, and the tail, are dusky; the belly is white. The smew is seen in England only in winter, at which season it will sometimes be met with at the southern parts of it; as also in France, in the neighbourhood of Picardy, where it is called *la Piette*: similar to this, we have heard it called in Kent by the name of *Magpie-diver*. On the continent we find it as far south as Carniola; frequents also Iceland, at which place, or some other arctic region, it passes the summer; and where it in course breeds, probably along with the other Mergansers; as it has been observed to migrate, in company with those birds, several kinds of ducks, &c. in their course up the Wolga, in February. It also inhabits America, having been sent from New-York, where it is probably a migratory species, as in Europe.

5. The minutus, or redheaded smew, weighs about 15 ounces; the length one foot four inches, the breadth one foot eleven: the bill is of a lead colour: the head slightly crested, and of a rust colour: the hind part of the neck is of a deep grey, the forepart clouded with a lighter colour of the same kind: the back and tail are of a dusky ash-colour, the legs of a pale ash-colour.—It is a native of Europe. Birds of this genus (Mr Latham observes) “are in general not so well-flavoured as those of the duck kind; yet we have often met with the last species in the London markets, and by some they are thought to be very little inferior to the wild duck; which last now and then partakes of the *fishy haut gout*, a flavour not disagreeable to the palates of the connoisseurs in good eating.”

MERIAN (MARIA SIBYLLA), a celebrated painter, born at Frankfort in 1647, was the daughter of Matthias Merian, a noted engraver and geographer.—As she showed a very early fondness for painting, she was instructed by Abraham Mignon; from whom she learned great neatness of handling and delicacy of colour.

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Merian.

Merida
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Meridiani.

lour. Her genius particularly led her to paint reptiles, flowers, and insects, which she designed after nature, and studied every object with a most curious and inquisitive observation; so that her works rose every day more and more into reputation. Frequently she painted her subjects in water-colours on vellum, and finished an astonishing number of designs, as she was equally indefatigable in her work and in her inquiries into the curiosities of nature. She drew the flies and caterpillars in all the variety of changes and forms in which they successively appear from their quiescent state till they become butterflies; and also drew frogs, toads, serpents, ants, and spiders, after nature, with extraordinary exactness and truth. She even undertook a voyage to Surinam, to paint those insects and reptiles which were peculiar to that climate; and at her return to her own country published two volumes of engravings after her designs, which are well known to the curious. She died in 1717. Her daughter Dorothea Henrietta Graff, who painted in the same style, and had accompanied her mother to Surinam, published a third volume collected from the designs of Sibylla; which complete work has been always admired by the learned, as well as by the professors of painting.

MERIDA, a strong town of Spain, in Estremadura, built by the Romans before the birth of Christ. Here are fine remains of antiquity, particularly a triumphal arch, but not now what it was formerly. It is seated in an extensive and fertile plain, 47 miles east of Elva, and 45 south by east of Alcantara. W. Lon. 6. 4. N. Lat. 38. 42.

MERIDA, a town of North America, in New Spain, and capital of the province of Yutacan, where the bishop and the governor of the province reside. It is inhabited by Spaniards and native Americans; is 30 miles south of the sea, and 120 N. E. of Campeachy. W. Lon. 89. 25. N. Lat. 20. 15.

MERIDA, a town of South America, in the kingdom of New Granada, seated in a country abounding with all kinds of fruits, 130 miles N. E. of Pampe-luna. W. Lon. 71. 0. N. Lat. 8. 30.

MERIDEN, or MIREDEN, a town of Warwickshire, 97 miles from London, in the London road, near Coventry. It is pleasantly situated, though in a wet clayey situation, and is not ill built. The church stands on an elevated spot, and contains some good monuments. There is an inn here, about half way from St Clement's forest to Coventry, one of the finest in this part of England, being built like a nobleman's seat.

MERIDIAN, in geography, a great circle supposed to be drawn through any part on the surface of the earth, and the two poles; and to which the sun is always perpendicular at noon. See GEOGRAPHY.

In astronomy, this circle is supposed to be in the heavens, and exactly perpendicular to the terrestrial one. See ASTRONOMY.

MERIDIANI, in antiquity, a name which the Romans gave to a kind of gladiators who entered the arena about noon after the bestiarii (who fought in the morning against beasts) had finished. They were thus called from *meridies*, i. e. *noon*, the time when they exhibited their shews. The meridiani were a sort of artless combatants, who fought man with man, sword in hand. Hence Seneca takes occasion to observe,

that the combats of the morning were full of humanity compared with those which followed.

MERIDIONAL DISTANCE, in navigation, the same with departure, or easting and westing; being the difference of longitude between the meridian, under which the ship now is, and any other meridian which she was under before.

MERIDIONAL parts, miles, or minutes, in navigation, are the parts by which the meridians in a Mercator's chart do increase, as the parallels of latitude decrease.

MERIONETHSHIRE, a county of North-Wales, is bounded on the north by Caernarvonshire and Denbighshire; on the east by Montgomeryshire; on the west by St George's channel, or the Irish sea; and on the south by the river Dyff, which parts it from Cardiganshire; extending 40 miles in length and 36 in breadth. It is divided into six hundreds, in which are four market-towns, 37 parishes, about 2590 houses, and 17,100 inhabitants. It lies in the diocese of Bangor, and sends one member to parliament. The air is very sharp in winter, on account of its many high barren mountains; and the soil is as bad as any in Wales, it being very rocky and mountainous. However, this county feeds large flocks of sheep, many goats, and large herds of horned cattle, which find pretty good pasture in the valleys. Besides these, among their other commodities may be reckoned Welch cotton, deer, fowl, fish, and especially herrings, which are taken on this coast in great plenty.

MERIT, signifies *desert*. This term is more particularly applied to signify the moral goodness of the actions of men, and the rewards to which those actions intitle them.

MERLIN (Ambrose), a famous English poet and reputed prophet, flourished at the end of the 5th century. Many surprising and ridiculous things are related of him. Several English authors have represented him as the son of an incubus, and as transporting from Ireland to England the great stones which form Stonehenge on Salisbury plain. Extravagant prophecies and other works are also attributed to him, on which some authors have written commentaries.

MERLIN, in ornithology. See FALCO.

MERLON, in fortification, is that part of a parapet which is terminated by two embrasures of a battery.

MERLUCIUS, the HAKE, in ichthyology. See GADUS.

MERMAID, or MERMAN, a sea-creature frequently talked of, supposed half human and half a fish.

However naturalists may doubt of the reality of *mermen* or *mermaids*, we have testimony enough to establish it; though, how far these testimonies may be authentic, we cannot take upon us to say. In the year 1187, as Laray informs us, such a monster was fished up in the county of Suffolk, and kept by the governor for six months. It bore so near a conformity with man, that nothing seemed wanting to it but speech. One day it took the opportunity of making its escape; and plunging into the sea, was never more heard of. *Hist. de Angleterre*, P. I. p. 403.

In the year 1430, after a huge tempest, which broke down the dikes in Holland, and made way for the

Meridional
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Mermaid.

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Mermaid, the sea into the meadows, &c. some girls of the town of Edam in West-Friesland, going in a boat to milk their cows, perceived a mermaid embarrassed in the mud, with a very little water. They took it into their boat, and brought it with them to Edam, dressed it in womens apparel, and taught it to spin. It fed like one of them, but could never be brought to offer at speech. Some time afterwards it was brought to Haerlem, where it lived for some years, though still showing an inclination to the water. Parival relates, that they had given it some notion of a Deity, and that it made its reverences very devoutly whenever it passed by a crucifix. *Delices de Hollande.*

In the year 1560, near the island of Manar, on the western coast of the island of Ceylon, some fishermen brought up, at one draught of a net, seven mermen and mermaids; of which several Jesuits, and among the rest F. Hen. Henriques and Dimas Bosquez, physicians to the viceroy of Goa, were witnesses. The physician, who examined them with a great deal of care, and made dissection thereof, asserts, that all the parts both internal and external were found perfectly conformable to those of men. See the *Hist. de la compagnie de Jesus*, P. II. T. IV. n° 276. where the relation is given at length.

We have another account of a merman, seen near the great rock called *Diamond*, on the coast of Martinico. The persons who saw it, gave in a precise description of it before a notary. They affirmed that they saw it wipe its hand over its face, and even heard it blow its nose.

Another creature of the same species was caught in the Baltic in the year 1531, and sent as a present to Sigismund king of Poland, with whom it lived three days, and was seen by all the court. Another very young one was taken near Rocca de Sintra, as related by Damian Goes. The king of Portugal and the grand master of the order of St James, are said to have had a suit at law to determine which party these monsters belong to.

In Pontopidan's Natural History of Norway, also, we have accounts of mermaids; but not more remarkable or any way better attested than the above.

MERNS, or KINCARDINSHIRE, a county of Scotland, stretching 27 miles in length and 20 in breadth, is bounded on the east by the German ocean, on the south by the river of North Esk, on the west by Angus, and on the north by the river Dee and Aberdeenshire. The country is pretty plain and level, fruitful in corn and pasturage, producing an infinite number of fir-trees, besides a great number of agreeable plantations; and along the sea-coasts there are many convenient creeks and harbours.—The people are Lowlanders, civil, hospitable, and industrious.—The name *Merns* is by some derived from that of a valiant nobleman, who, subduing the country, received it in reward from Kenneth II. Camden supposes it to retain part of the ancient name of *Vernicones*. The other name is derived from *Kincardin*, its ancient capital, now an inconsiderable village. The stocking-trade employs the natives from the banks of the Dee to Stone-hive; from thence to the North Esk they are wholly employed in weaving.

MERODACH was an ancient king of Babylon, who was placed among the gods, and worshipped by

the Babylonians. Jeremiah (chap. I. 2.), speaking of the ruin of Babylon, says, "Babylon is taken, Bel is confounded, Merodach is broken in pieces, her idols are confounded, her images are broken in pieces." We find certain kings of Babylon, in whose names that of Merodach is contained: for example, Evilmerodach and Merodach-baladan. Evilmerodach was the son of Nebuchadnezzar the Great, and had for his successor the wicked Belshazzar. Merodach-baladan, son of Baladan king of Babylon, having heard that Hezekiah had been cured miraculously (Isa. xxxix.), and that the sun had gone backwards to give him an assurance of his recovery, sent him presents, and made him compliments upon the recovery of his health. Ptolemy calls him *Mardocempadus*; and says, that he began to reign at Babylon 26 years after the beginning of the era of Nabonassar, that is, in the year of the world 2283.

MEROE (anc. geog.), an island of Ethiopia beyond Egypt, in the Nile; with a cognominal town, the metropolis of the Ethiopians.

The Jesuits have endeavoured to prove, that the province of Gojam in Abyssinia is the Meroë of the ancients; but this is strongly contested by Mr Bruce, who is of opinion that it must be looked for somewhere between the source of the Nile and its union with the Atbara. The latter, he thinks, is very plainly the Astaboras of the ancients; and Pliny says that this stream incloses the left side of Meroë as the Nile does the right; in which case we must suppose him looking southward from Alexandria, otherwise the words would not apply.

We are told by Diodorus Siculus, that Meroë had its name from a sister of Cambyfes king of Persia, who died there in the expedition undertaken by that prince against the Ethiopians. His army perished with hunger and thirst in the deserts beyond Meroë; which could not have happened if they had reached Gojam, the latter being one of the most plentiful countries in the world. A further proof that Gojam cannot be the ancient Meroë is, that the latter was inclosed between the rivers Nile and Astaboras, while Gojam is almost entirely surrounded by the Nile. If the ancients were acquainted with Gojam, they must also have been acquainted with the fountains of the Nile, which we certainly know they were not. Pliny says that Meroë, the most considerable of all the islands of the Nile, was called *Astaboras*, from the name of its left channel, which cannot be supposed any other than the junction of the Nile and Atbara. He informs us moreover, that the sun was vertical twice in the year, viz. when proceeding northward he entered the 18th degree of Taurus, and when returning he came to the 14th degree of Leo; but this could never be the case with Gojam, which lies in about 10 degrees north latitude.

Again the poet Lucan describes Meroë by two circumstances which cannot apply to any other than the peninsula of Atbara. One is, that the inhabitants were black; which was the case with the Gymnosophists and first inhabitants, and which has been the case with all the rest down to the Saracen conquest: but the inhabitants of Gojam, as well as the other Abyssinians, are fair, at least greatly different in complexion from the blacks; they are also long haired.

and

Meroë,
Merom.

and nobody imagined that they ever had philosophers or science among them, which was eminently the case with the ancient inhabitants of Meroë. The other circumstance is, that the ebony tree grew in the island of Meroë, which at this day grows plentifully in the peninsula of Atbara, and part of the province of Kuara, but not in Gojam, where the tree could not subsist on account of the violent rains which take place during six months of the year. Mr Bruce mentions another circumstance quoted from the poet Lucan, which likewise tends to prove the identity of Meroë and Atbara; viz. that though there are many trees in it, they afford no shade. This our traveller found by experience, when returning from Abyssinia through Atbara. "The country (says he) is flat, and has very little water. The forest, though thick, afforded no sort of shade, the hunters for the sake of their sport, and the Arabs for destroying the flies, having set fire to all the dry grass and shrubs; which passing with great rapidity in the direction of the wind from east to west, though it had not time to destroy the trees, did yet wither, and occasion every leaf that was upon them to fall, unless in those spaces where villages had been and where water was. In such spots a number of large spreading trees remained full of foliage; which from their great height and being cleared of underwood, continued in full verdure, loaded with large, projecting, and exuberant branches. But even here the pleasure that their shade afforded was very temporary, so as to allow us no time for enjoyment. The sun, so near the zenith, changed his azimuth so rapidly, that every few minutes I was obliged to change the carpet on which I lay, round the trunk of the tree to which I had fled for shelter; and though I lay down to sleep perfectly screened by the trunk or branches, I was presently awakened by the violent rays of a scorching sun, the shade having passed beyond me. In all other places, though we had travelled constantly in a forest, we never met with a tree that could shade us for a moment, the fire having deprived them of all their leaves." The heat of Atbara is excessive, the thermometer having been observed at $119\frac{1}{2}^{\circ}$: two of Mr Bruce's company died of thirst, or at least of the consequences of drinking after extreme thirst. The inhabitants live in the greatest misery, and are continually in danger from the neighbouring Arabs, who, by destroying and burning their corn, are able to reduce them to a starving condition. Notwithstanding all their disadvantages, however, they have a manufacture of coarse cotton towels, of a size just sufficient to go round the waist, which pass current as silver money throughout the whole country.

MEROM, (anc. geog.) The waters of Merom, at which place Jabin and the other confederate kings met to fight Joshua (xi. 5.), are generally supposed by the learned to be the lake Semechon, which lies between the head of the river Jordan and the lake Genesareth; since it is agreed on all hands, that the city Hazor, where Jabin reigned, was situated upon this lake. But others think, that the waters of Merom or Merome were somewhere about the brook Kishon, since there is a place of that name mentioned in the account of the battle against Sisera (Judg. v. 21.) And it is more rational to think, that the confederate kings

advanced as far as the brook Kishon, and to a pass which led into the country, to hinder Joshua from penetrating it, or even to attack him in the country where he himself lay encamped, than to imagine that they waited for him in the midst of their own country; leaving all Galilee at his mercy, and the whole tract from the brook Kishon to the lake Semechon.

MEROPE (fab. hist.) one of the Atlantides. She married Sisyphus the son of Æolus, and like her sisters was changed into a constellation after death. It is said that in the constellation of the Pleiades the star of Merope appears more dim and obscure than the rest, because she, as the poets observe, married a mortal, while her sisters married some of the gods or their descendants.

MEROPS (fab. hist.) a king of the island of Cos, who married Clymene, one of the Oceanides. He was changed into an eagle, and placed among the constellations. Also a celebrated soothsayer of Perseus in Troas, who foretold the death of his sons Adrastus and Amphius, who were engaged in the Trojan war. They slighted their father's advice, and were killed by Diomedes.

MEROPS, in ornithology, a genus belonging to the order of picæ. The bill is crooked, flat, and carinated; the tongue is jagged at the point; and the feet are of the walking kind. 1. The apiafter, or bee-eater, has an iron-coloured back; the belly and tail are of a bluish green; and the throat is yellow. This bird inhabits various parts of Europe, on the continent, though not in England; yet is said to have been seen in Sweden, and flocks of them have been met with at Anspach in Germany in the month of June. They are now and then seen in Lorraine, though only in pairs; and are not unfrequent in other parts, since Kramer talks of their building the nest in the sandy crags of the Danube. They are met with in Italy and the south of France; and in Candia and other islands of the Mediterranean, they are in plenty, as well as in Palestine and Arabia, being very common in the woods about Yemen, where they are called Schæghagha. It takes the name of bee-eater from its being very fond of those insects; but, besides these, it will catch gnats, flies, cicadæ, and other insects, on the wing, like the swallow. Willoughby tells us, from Belon, "that its singular elegance invites the Candy boys to hunt for it with cicadæ, as they do for those greater swallows called *swifts*, after this manner:—Bending a pin like a hook, and tying it by the head to the end of a thread, they thrust it through a cicada (as boys bait a hook with a fly), holding the other end of the thread in their hands: the cicada, so fastened, flies nevertheless in the air; which the Merops spying, flies after it with all her force; and catching it, swallows pin and all, where-with she is caught."—This bird is said to be in most plenty in the isle of Candia; and, in defect of insects, to eat seeds of many kinds; and Ray supposes, from its similarity to the kingfisher, it may possibly feed on fish. Most probably some think it good to eat, as Willoughby saw many of them exposed for sale in the markets of Rome. These birds make their nests in deep holes in the banks of rivers, like the sand martin and kingfisher, at the end of which the female lays from five to seven white eggs, rather less than those

Merope,
Merops.

Merops
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Merfa.

Plate
CCXCIV.

of a blackbird. The nest itself is composed of moss. 2. The viridis, or Indian bee-eater, is green, with a black belt on the breast; and the throat and tail are black. It inhabits Bengal. 3. The congener is yellowish, with a green rump. It inhabits the south of Europe. 4. The superciliosus is green, with a white line both above and below the eyes, and a yellow throat. It is found in Madagascar, where the natives give it the name of *Patirich Tirich*. 5. The cinereus is variegated with red and yellow, with the two longest quill-feathers of the tail red. It is a native of Mexico. 6. The erythropterus, or red-winged bee-eater, is in length six inches; the bill is one inch, and black: the upper parts of the head, body, wings, and tail coverts, are green brown, deepest on the head and back, lightest on the rump and tail coverts: behind the eye is a spot of the same, but of a very deep colour: the quills and tail are red, tipped with black; the last two inches in length: the throat is yellow; the under parts of the body are a dirty white; and the legs black.—This inhabits Senegal, from which place a well-preserved skin was brought by M. Adanson. (See fig. A.) 7. The wattled bee-eater (fig. B.) is the size of a cuckoo, in length about 14½ inches. The feathers on the upper part of the head, being longer than the rest, give the appearance of a crest; those of the under part are smooth; the plumage for the most part is brown; the feathers are long and pointed, and each feather has a streak of white down the middle; under the eye, on each side, is a kind of wattle, of an orange colour; the middle of the belly is yellow; the tail is wedge-shaped, similar to that of the magpie, and the feathers are tipped with white; the bill and legs are brown.—This bird is supposed to be peculiar to New Holland. There are 14 or 15 other species.

MEROVINGIAN CHARACTER, derives its name from Meroüée, the first king of France of that race, which reigned 333 years, from Pharamond to Charles Martel. This race is said by some to have terminated in Childeric III. A. D. 751. There are many MSS. in the French libraries still extant in this character.

MEROZ, (anc. geog.), a place in the neighbourhood of the brook Kishon, whose inhabitants refusing to come to the assistance of their brethren when they fought with Sisera, were put under an anathema (Judges v. 23.) "Curse ye Meroz, says the angel of the Lord; curse ye bitterly the inhabitants thereof: because, &c." Some have thought that Meroz is the same as Merus or Merom; and this F. Calmet thinks the most probable opinion in this matter. Others will have it, that Meroz was a mighty man, who dwelt near the Kishon, and not caring to come to the assistance of Barak and Deborah, was excommunicated by the angel of the Lord by the sound of 400 trumpets. The angel of the Lord, according to some, was Barak, the general of the Lord's army; but according to others he was the high-priest for the time being, or a prophet.

MERSA, a town of Barbary, pleasantly situated about 11 miles from the city of Tunis, and two from Melcha the site of ancient Carthage. The Bey has here two country-houses, one of them very costly work, built by Hassan Bey surnamed the *Good*. From these are orange gardens reaching almost to the sea-

Nº 211.

shore; on the edge of which is a famous well of sweet water, esteemed the best and lightest in the kingdom. Close to this is a coffee-house, where numbers of people from the neighbouring places resort to drink coffee, and a glass of this natural luxury so peculiarly enjoyed in the eastern countries. In the middle of the court is a large mulberry-tree, under the shade of which they sit and smoke and play at chess; inhaling the comfortable sea-breeze that refreshes this delightful spot. The water is drawn up by a camel with the Persian wheel.

Here are the remains of an ancient port, or cothou, (supposed to be an artificial one), built by the Carthaginians after Sapii had blocked up the old port, nothing but the turret or light-house being left.

MERS or MERSE, a county of Scotland, called also *Berwickshire*. This last name it derives from the town of Berwick, which was the head of the shire before it fell into the hands of the English, and obtained the appellation of *Mers* or *March*, because it was one of the borders towards England. It is washed on the south and east by the river Tweed and the German Ocean, bounded on the west by Tweedale, and on the north by Lothian. It extends 24 miles from east to west, and the breadth amounts to 16. The face of the country is rough and irregular, exhibiting hills, moors, and mosses, with intermediate valleys, which are pleasant and fruitful. It is watered by many streams; and particularly by the famous Tweed, which, rising from the same hills that give birth to the Clyde and Annan, runs with a rapid course through Tweedale forest and Teviotdale, and after a course of 50 miles disembogues itself into the German Ocean. Notwithstanding the length of its course, it is not navigable above Berwick, where there is a noble bridge over it, consisting of 15 arches. There is another fine one, called the *Union Bridge*, at Coldstream. There is a third at Melrose, a fourth at Peebles, and a fifth at Kelso. The shire of Berwick is generally distinguished into the three divisions of Mers, Lammermuir, and Lauderdale. The Mers is low, pleasant, and tolerably fruitful in corn. Lammermuir is a hilly country, abounding with game, and yielding good pasture for sheep and black cattle. Lauderdale is a tract of land lying on each side of the river Lauder, agreeably varied with hill, dale, and forest, producing good store of corn and pasturage, and giving the title of earl to the family of Maitland: but the most fruitful and populous parts of Berwickshire, are those that lie along the Tweed, and on both sides of the lesser rivers White Water, Black Water, and Eye. The seats of noblemen and gentlemen abound in this county.

MERSENNE (Marin), in Latin *Merfennus*, a learned French author, born at Oysé, in the province of Maine, anno 1588. He studied at La Fleche at the same time with Des Cartes; with whom he contracted a strict friendship, which lasted till death. He afterwards went to Paris, and studied at the Sorbonne; and in 1611 entered himself among the minims. He became well skilled in Hebrew, philosophy, and mathematics. He was of a tranquil, sincere, and engaging temper; and was universally esteemed by persons illustrious for their birth, their dignity, and their learning.

Mersey
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Merus.

learning. He taught philosophy and divinity in the convent of Nevers, and at length became superior of that convent; but being willing to apply himself to study with more freedom, he resigned all the posts he enjoyed in his order, and travelled into Germany, Italy, and the Netherlands. He wrote a great number of excellent works; the principal of which are, 1. *Quæstiones celeberrimæ in Genesim.* 2. *Harmonicorum libri.* 3. *De sonorum natura, causis, & effectibus.* 4. *Cogitata physico-mathematica.* 5. *La verité des Sciences.* 6. *Les questions inouies.* He died at Paris in 1648. He had the reputation of being one of the best men of his age. No person was more curious in penetrating into the secrets of nature, and carrying all the arts and sciences to their utmost perfection. He was in a manner the centre of all the men of learning, by the mutual correspondence which he managed between them. He omitted no means to engage them to publish their works; and the world is obliged to him for several excellent discoveries, which, had it not been for him, would perhaps have been lost.

MERSEY, a river of England, that runs through the counties of Lancaster, York, and Chester, and empties itself into the Irish sea at Liverpool. By the late inland navigation, it has communication with the rivers Dee, Ribble, Ouse, Trent, Darwent, Severn, Humber, Thames, Avon, &c.; which navigation, including its windings, extends above 500 miles, in the counties of Lincoln, Nottingham, York, Lancaster, Westmoreland, Chester, Stafford, Warwick, Leicester, Oxford, Worcester, &c.

MERSEY-Island, an island of Essex, at the mouth of the Coln, south of Colchester. It was seized by the Danes in the reign of King Alfred, for their winter-quarters. It had eight parishes, now reduced to two, viz. east and west Mersey. The island had a block-house; and, in the Dutch war, the parliament put 1000 men in it.

MERULA (George), an Italian of extraordinary parts and learning, born at Alexandria in the duchy of Milan about the year 1420. He taught youth at Venice and Milan for 40 years, and laboured abundantly in restoring and correcting ancient authors. He wrote, and addressed to Lewis Sforza, *Antiquitates Vicecomitum*; or "The Actions of the Dukes of Milan," in 10 books; with some other things in the same way. His death, in 1494, is said not to have grieved any body; as he lived in a state of war with, and abused, almost all his cotemporary scholars.

MERULA (Paul), born at Dort in Holland, a famous lawyer, historian, and linguist, was professor of history in the university of Leyden after Lipsius. He wrote, 1. Commentaries on Ennius; 2. The life of Erasmus and Junius; 3. A cosmography; 4. A treatise of law; and died in 1607.

MERULA, or Blackbird, in ornithology. See TURDUS.

MERUS, (anc. geog.), a mountain of the Hither India, hanging over the city Nyssa, built by Bacchus, and situated between the rivers Cophen and Indus. The name, denoting the thigh, gave rise to the fable of Bacchus being inserted into Jupiter's thigh, and being born twice; because in this mountain he and his

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army are said to have been preserved, when disease and pestilence raged in the plains below.

MESARAIC-VESSELS, in the general sense, are the same with MESENTERIC.

In common use, mesaraic is more frequently applied to the veins, and mesenteric to the arteries, of the mesentery. See ANATOMY.

MESCHED, a considerable town of Persia, and in the province of Khorassan; fortified with several towers, and famous for the magnificent sepulchre of Iman Risa, of the family of Ali, to whom the Persians pay great devotion. It is seated on a mountain near this town, in which are fine torquise-stones; in E. Long. 59. 25. N. Lat. 37. 0.

MESEMBRYANTHEMUM, FIG-MARIGOLD, in botany: A genus of the pentagynia order, belonging to the icosandria class of plants; and in the natural method ranking under the 13th order, *Succulentæ*. The calyx is quinquefid; the petals are numerous and linear; the capsule is fleshy, inferior, and monospermous. There are between 40 and 50 species; all African plants, from the Cape of Good Hope; near 40 of which are retained in our gardens for variety. Of these only one is annual, and the most remarkable of them all. It is called the *crystallinum*, *diamond ficoides*, or *ice-plant*. It rises with a short, thick, succulent stalk, dividing low into many trailing, very spreading, succulent branches, bespangled all over with icy pimples; very pellucid and glittering; oval, undulate, alternate, papulose or pimply, glittering leaves; and from the sides of the branches, numerous, almost close sitting, white flowers, tinged with red or crimson; succeeded by plenty of seed in autumn. This singular and curious plant, being closely covered with large pellucid pimples, full of moisture shining brilliantly like diamonds, is in great esteem. It is a very tender plant while young; and is raised annually from seed by means of hot-beds. In June it will endure the open air till October, when it perishes; but if placed in a hot-house in autumn, it will often live all winter. It is commonly planted in pots for the convenience of removing from place to place; but if planted in the full ground, it grows considerably stronger, even to luxuriance: however, when confined in pots, it flowers more abundantly.

The other species are most durable in stem and foliage. Some are shrubby; others pendulous, with loose straggling stems, and branches inclining to the ground; while others have no stalks at all: their leaves are universally very thick, succulent, fleshy; and of many various shapes, situations, and directions; while some are curiously punctured, or dotted with transparent points, and some have pellucid pimples, as already mentioned: they afford a very agreeable variety at all times in the year, and merit a place in every collection. They are green-house plants, and are propagated by cuttings of their stalks and branches.

MESENTERIC, or MESARAIC, an epithet given to two arteries arising from the descending aorta, and proceeding to the mesentery. See MESENTERY.

MESENTERITIS, or *Inflammation of the MESENTERY*. See MEDICINE, n° 191.

MESENTERY, MESENTERIUM, (formed of $\mu\epsilon\sigma\epsilon\tau\epsilon\rho$ middle,

Mesher
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Mespilus.

middle, and *εντερον intestine*), in anatomy, a fatty membranous body, thus called as being placed in the middle of the intestines, which it connects to one another. See ANATOMY, n 94.

MESHES of NETS, the openings or interstices between the threads.

MESN, or MESNE, a term in law, signifying him who is lord of a manor, and so hath tenants holding of him; yet he himself holds of a superior lord.

The word is properly derived from *maïne, quasi minor natu*; because his tenure is derived from another, from whom he holds.

MESN also denotes a writ, which lieth where there is lord mesn and tenant; and the tenant is distrained for services due from the mesn to the superior lord.

This is in the nature of a writ of right; and in this case the tenant shall have judgment to be acquitted or indemnified by the mesne lord; and if he makes default therein, or does not appear originally to the tenant's writ, he shall be forejudged of his mesnalty, and the tenant shall hold immediately of the lord paramount himself.

MESPOCHRI, were musicians among the ancients who presided in concerts, and by beating a wooden desk regularly with their feet, directed the measure of the music. For the purpose of beating time, they wore wooden clogs, called by the ancients *crupezia*, which occasioned the sound to be better heard.

MESOCOLON, in anatomy, that part of the mesentery, which, having reached the extremity of the ileum, contracts and changes its name. See ANATOMY, n 94.

MESOLOGARITHMS, according to Kepler, are the logarithms of the co-sines and co-tangents; the former of which were called by Baron Napier *anti-logarithms*, and the latter *differentials*.

MESOPOTAMIA, the ancient name of the province of DIARBECK, in Turkey in Asia. It is situated between the rivers Euphrates and Tigris; having Assyria on the east, Armenia on the north, Syria on the west, and Arabia Deserta with Babylonia on the south. The Hebrews called it *Padan-aram* (Gen. xxviii. 2. &c.), and *Aram Nabaraim* (title of Psal. lx.) or *Aram of the two rivers*, because it was first peopled by Aram father of the Syrians, and is situated between the two rivers already mentioned. This country is much celebrated in scripture, as being the first dwelling of men both before and after the deluge; and because it gave birth to Phaleg, Heber, Terah, Abraham, Nahor, Sarah, Rebekah, Rachel, Leah, and to the sons of Jacob. Babylon was in the ancient Mesopotamia, till, by vast labour and industry, the two rivers of the Tigris and Euphrates were united into one channel. The plains of Shinar were in the same country. Often they gave it the name of Mesopotamia (Deut. xxiii. 4. &c.) and sometimes that of Syria, (Hosea xii. 12.) Balaam son of Beor was of Mesopotamia, Deut. xxiii. 4. Chusban-rishathaim king of Mesopotamia kept the Hebrews in subjection some time after the death of Joshua, Judg. iii. 8.

MESOPTERYGIUS, in ichthyology, a term applied to such fishes as have only one back-fin, and that situated in the middle of the back.

MESPILUS, the MEDLAR, in botany: A genus

of the pentagynia order, belonging to the icofandria class of plants; and in the natural method ranking under the 36th order, *Pomaceæ*. The calyx is quinquefid; the petals are five; the berry is inferior and pentaspermous. There are seven species, viz.

1. The Germanica, German mespilus, or common medlar, rises with a deformed tree-stem, branching irregularly 15 or 20 feet high; spear-shaped leaves, downy underneath; and large close sitting, white flowers, singly from the sides of the branches; succeeded by large roundish brown fruit, the size of middling apples, which ripen in October, but are not eatable till beginning to decay. The varieties are, common great German medlar—smaller Nottingham medlar—spear-shaped Italian medlar. This species and varieties are all cultivated in the English gardens for the fruit: but the German or Dutch medlar, and the Nottingham kind, are the most common; and the latter of which two, though a smaller fruit, is rather preferable for richness and poignancy of flavour. These kinds of fruit are never eatable until they begin to rot; for when firm and sound, they are of a singularly austere disagreeable taste; yet having lain some time after being gathered, till they begin to assume a state of decay and become soft, they acquire a delicious flavour, extremely agreeable to many, though to others altogether unpalatable.—All these sorts ripen in the latter end of October, or beginning of November; when being gathered, some should be laid in moist bran, in several layers, to forward their decay; others on straw in the fruitery: those in the bran will begin to be ready for use in about a fortnight, and those laid on straw will come gradually forward in succession.

2. The arbutifolia, arbutus-leaved mespilus, hath a shrubby stem, branching erectly five or six feet high; lanceolate, crenated, alternate leaves, downy underneath; and from the sides and ends of the branches, small white flowers in clusters; succeeded by small, roundish, purple fruit, like haws.

3. The amelanchier, or shrubby medlar, with black fruit, rises with several shrubby, slender, hairy stems, branching moderately about four feet high, having purplish branches; oval, serrated leaves, downy underneath; and small white flowers, in clusters at the ends of the branches: succeeded by small black fruit.

4. The chamæ-mespilus, or dwarf medlar, commonly called *bastard quince*, hath a shrubby, slender, smooth stem, branching weakly four or five feet high, having purplish branches; oval, serrated, smooth leaves, on long foot-stalks; and from the axillas, purple flowers, collected into round heads, with narrow, purplish, deciduous bractæ; succeeded by small red fruit.

5. The cotoneaster, commonly called *dwarf quince*, rises with a shrubby, smooth stem, branching four or five feet high, the branches slender and reddish; oval entire leaves on short foot-stalks; and from the axillas, small close-sitting purple flowers, two or three together; succeeded by small roundish, bright-red fruit.

6. The Canadensis, Canada snowy mespilus, hath a shrubby, smooth stem, branching four or five feet high, with smooth, purplish branches; oval-oblong, serrated, smooth leaves, on long footstalks; and all the

Mespilus.

Mespilus the branches terminated by clusters of snowy-white flowers; succeeded by small, purplish fruit, like haws.

Messalina. 7. The pyracantha, or ever-green thorn, rises with a shrubby, spinous stem, branching diffusely 12 or 14 feet high, the branches slender and flexible, with a dark greenish bark, armed with long sharp spines; spear-shaped-oval, crenated, ever-green leaves; and all the shoots terminated by numerous clusters of whitish flowers; succeeded by large bunches of beautiful red berries, remaining all winter, and exhibiting a very ornamental appearance.

All these seven species of *mespilus* are of the tree and shrub kind; the first six sorts are deciduous, the seventh an ever-green; the leaves are universally simple; those of the *mespilus Germanica* very large, the others mostly of moderate size, and which in most of the sorts grow upon short footstalks. They all flower abundantly every summer, the flowers universally hermaphrodite, and consisting each of five large roundish petals, 20 stamina, and five styles. They are all very hardy, and succeed in any common soil and situation, and their propagation and culture is very easy.

The first sort and varieties are cultivated as fruit-trees, principally as standards, sometimes also as espaliers for variety. The other species are very proper furniture for any ornamental plantation, where they will make an agreeable variety with their different foliage; and their flowers make a fine appearance, as also the fruit in autumn and winter, which, if not devoured by birds, remain long on the branches, and afford a fine variety in those seasons. The pyracantha, being rather of flexible growth, is most commonly trained against walls or the fronts of houses, both for the support of its flexible branches, and that it may exhibit its berries more ornamentally.

When it is designed to have any of the common medlars as fruit-trees, they may be trained either as dwarfs, for dwarf standards, or for espaliers, or trained as half or full standards, and managed in either of those modes of training nearly as other fruit-trees, particularly the apple and pear; and are raised either by seed, by grafting, or by budding; but either of the two latter methods are the most certain for continuing the sorts without variation: observing, after shortening their first shoots from the graft or bud, where it shall seem necessary to force out a proper supply of wood to form a head, to train the branches afterwards principally at full length, and let the standards branch out in their own way.

MESS, in a military sense, implies a number of soldiers, who, by laying away a certain proportion of their pay towards provisions, mess together: six or eight is generally the number of each mess. Experience proves, that nothing contributes more to the health of a soldier, than a regular and well chosen diet, and his being obliged every day to boil the pot: it corrects drunkenness, and in a great measure prevents gaming, and thereby desertion.

MESSALINA (Valeria), a daughter of Messala Barbatus. She married the emperor Claudius, and disgraced herself by her cruelties and incontinence. Her husband's palace was not the only seat of her lasciviousness, but she prostituted herself in the public streets, and few men there were at Rome who could not boast of having enjoyed the favours of the impure

Messalina. Her extravagancies at last irritated her husband, who commanded her to appear and answer all the accusations which were brought against her: upon which she attempted to destroy herself; and when her courage failed, one of the tribunes who had been sent to her dispatched her with his sword. It is in speaking of her debaucheries and lewdness that Juvenal says,

Et lassata viris, necdum satiata, recessit.

Her name has become a common appellation to denote a woman of shameless and inordinate lust.

MESSANA, (anc. geog.), the first town of Sicily on crossing over from Italy, situated on the strait now called the *Faro*, (Italicus). Anciently called *Zancle*, according to Diodorus Siculus, from king Zancleus; or, according to others, from the Sicilian term *Zanclon*, denoting a sickle, alluding to the curvity of the coast: a name appropriated by the poets; and hence *Zanclai*, the people, (Herodotus, Pausanias). The other name *Messana* is from the *Messenii* of Peloponnesus, (Strabo). Thucydides ascribes its origin to Anaxilas the Messenian, tyrant of Rhegium, who received all comers, calling the town after the name of his country. The Greeks always call it *Messene*; the Romans *Messena* constantly, to distinguish it from *Messene* of Peloponnesus. Now MESSINA, lately ruined by earthquakes.

MESSENA, or MESSENE, an inland town, and the capital of Messenia, a country of Peloponnesus; erroneously placed by Ptolemy on the coast. It was built by Epaminondas, who recalled all the Messenian exiles, and gave the town the name of *Messene*. A place vying in point of strength and situation with Corinth, according to Strabo; and therefore Demetrius Phalerius advised Philip, father of Perseus, that if he wanted to have Peloponnesus in his power, he should make himself master of these two towns, as thus he would have the ox by both horns.

MESSENGERS, are certain officers chiefly employed under the direction of the secretaries of state, and always in readiness to be sent with all kinds of dispatches foreign and domestic. They also, by virtue of the secretaries warrants, take up persons for high treason, or other offences against the state. The prisoners they apprehend are usually kept at their own houses, for each of which they are allowed 6s. 3d. per day by the government: and when they are sent abroad, they have a stated allowance for their journey, viz. 30l. for going to Paris, Edinburgh, or Dublin; 25l. for going to Holland; and to other places in the same proportion; part of which money is advanced for the expence of their journey. Their standing salary is 45l. per annum; and their posts, if purchased, are esteemed worth 300l. The messengers wait 20 at a time, monthly, and are distributed as follows, viz. four at court, five at one secretary's office, five at another, two at the third for North Britain, three at the council-office, and one at the lord chamberlain's of the household.

MESSENGERS, in Scotland. See LAW, Part III. p. 651, par. 16.

MESSENGERS of the Exchequer, are four officers who attend the exchequer, in the nature of pursuivants, and carry the lord treasurer's letters, precepts, &c.

MESSENGER of the Press, a person who, by order

Messana
||
Messenger

Messenia. of the court, searches printing-houses, booksellers shops, &c. in order to discover the printers or publishers of seditious books, pamphlets, &c.

MESSENIÀ, a country in the south of Peloponnesus, mostly maritime, situated between Elea to the west, and Laconica to the east. Anciently a part of Laconica under Menelaus, and called *Messene* by Homer; interpreted by the scholiast, *Messenæ Regiâ*. *Messenii*, the people, reduced to a state of slavery and subjection by the Spartans; *Messenius*, the epithet.

This country is famous in history, on account of the resistance made by the Messenians against the Spartans, and the exploits of their hero Aristomenes. The first hostilities commenced about the year 652 B. C. on what occasion is uncertain. Though the Messenians were inferior in the knowledge of the art of war to the Spartans; yet, by keeping for some time on the defensive, they improved so much, that in three years time they found themselves in a capacity of giving battle to their enemies in the open field; nor did they appear to be in any degree inferior either in courage or conduct: the war was therefore protracted, with various success, on both sides. At last, both consulted the oracle at Delphi; and received for answer, "that whoever should first dedicate 100 tripods in the temple of Jupiter at Ithome, a strong-hold of the Messenians, should be masters of the country." The inhabitants of Messenia, on hearing this, having no money to make the tripods of brass, fell to cutting them out in wood; but before this could be accomplished, a Spartan having got into the city by stratagem, dedicated 100 little tripods of clay: which threw the Messenians into such despair, that they at last submitted to the Spartans.

The new subjects of Sparta were treated with the utmost barbarity by these cruel tyrants; so that a new war commenced under Aristomenes, a man of unconquerable valour, and enthusiastically fond of liberty. He perceived that the Argives and Arcadians, who were called the *allies* of the Lacedæmonians, adhered to them only through fear of their power; but that in reality they hated them, and wished to revenge the injuries they had done them. To these Aristomenes applied; and receiving an answer conformable to his wishes, he engaged his countrymen unanimously to take up arms. About a year after the revolt began, and before either party had received any auxiliaries, the Spartans and Messenians met at a village called *Dera*, where an obstinate engagement ensued. Aristomenes was conceived to have performed more than mortal achievements: in gratitude therefore, respect being also had to his royal descent, his countrymen unanimously saluted him *king*; which title he modestly waved, alleging, that he took up arms to set them free, and not to make himself great: he consented, however, to accept the title of *general*, with a power of doing whatsoever he thought requisite for the service of the public. Knowing well the superstition of the age in which he lived, he resolved to intimidate the Spartans, by showing them what he was sure they would take for an ill omen. Disguising himself therefore, he went privately to the city, where, in the night, he hung up a shield on the wall of the temple of Minerva, with this inscription: *Aristomenes*

*dedicates this, out of the spoils of the Spartans, to the god-
dess.* It was easily perceived that this war would be both long and bloody; the Lacedæmonians therefore sent deputies to Delphi, to inquire of the oracle concerning its event: the answer they received was, *That it behoved the Spartans to seek a leader from Athens.* The Athenians, naturally envious of the Spartans, granted their request indeed, but in such a manner as manifested their spite; for they sent them for a general Tyrtæus, a schoolmaster and poet, lame of one foot, and who was suspected to be a little out of his wits. But here their skill failed them; for this captain, notwithstanding his despicable appearance, proved of great consequence to Sparta, teaching them how to use good, and how to bear up under evil fortune.

In the mean time, Aristomenes had drawn together a mighty army, the Eleans, Argives, Sicyonians, and Arcadians, having sent troops to his assistance; the Spartans in this, as in the former war, having no ally but Corinth. The Spartan kings, according to the custom of their city, no sooner took the field, than, notwithstanding their inferiority in number, they offered the enemy battle, which Aristomenes readily accepted.—It was long, obstinate, and bloody; but in the end the Messenians were victorious, and the Lacedæmonians put to flight with a great slaughter. It is scarce to be conceived how much the Spartans were struck with this defeat: they grew weary of the war, dissatisfied with their kings, diffident of their own power, and in a word sunk into a state of general uneasiness and want of spirit. It was now that the Athenian general convinced them, that he was capable of fulfilling all the promises of the oracle; he encouraged them by his poems, directed them by his counsels, and recruited their broken armies with chosen men from among the Helotes. Aristomenes, on the other hand, acted with no less prudence and vigour. He thought it not enough to restore the reputation of the Messenians, if he did not also restore their wealth and power: he therefore taught them to act offensively against their enemies; and, entering the territories of Sparta, he took and plundered Pharæ, a considerable borough in Laconia, putting all such as made any resistance to the sword, carrying off at the same time an immense booty. This, however, was an injury which the Spartans could not brook with patience; they therefore sent immediately a body of forces to overtake the Messenians, which accordingly they did: but Aristomenes routed these pursuers, and continued to make a mighty slaughter of them, till such time as he was disabled by having a spear thrust in his side, which occasioned his being carried out of the battle. His cure, which took up some time, being finished, he resolved to carry the war even to the gates of Sparta; and to that purpose raised a very great army: but, whether he found his design impracticable, or was really diverted by some dream, he gave out, that Castor and Pollux, with their sister Helena, had appeared to him, and commanded him to desist. A short time after this retreat, going with a small party to make an incursion, and attempting to take prisoners some women who were celebrating religious rites near Egila, a village in Laconia, those zealous matrons fell upon him and his soldiers with such fury, that they put them to flight, and took him prisoner:

Messenia. prisoner: however, he soon afterwards made his escape, and rejoined his forces. In the third year of the war, the Spartans with a great force entered Messenia, whither Aristocrates king of Arcadia was come, with a great body of troops, to the assistance of his allies: Aristomenes therefore made no difficulty of fighting when the Spartans approached; but they entering privately into a negociation with Aristocrates, engaged him with bribes and promises to betray his confederates. When the battle began, the deceitful Arcadian represented to the forces under his command the mighty danger they were in, and the great difficulty there would be of retreating into their own country, in case the battle should be lost: he then pretended, that the sacrifices were ominous; and, having terrified his Arcadians into the disposition of mind fittest to serve his purpose, he not only drew them off from both wings, but, in his flight, forced through the Messenian ranks, and put them too in confusion. Aristomenes and his troops, however, drew themselves into close order, that they might defend themselves the best they could: and indeed they had need of all their valour and skill; for the Lacedæmonians, who expected this event, immediately attacked and surrounded them on all sides. Fortune was, on this occasion, too powerful either for the courage or the conduct of the Messenians; so that, notwithstanding their utmost efforts, most of their army were cut to pieces, and amongst them the chief of their nobility. Aristomenes, with the poor remains of his shattered forces, retired as well as he could; and, perceiving that it was now impossible to maintain the war against the Lacedæmonians upon equal terms, he exhorted his countrymen to fortify mount Era, and to make the best dispositions possible for a long defence. He likewise placed garrisons in Pylus and Methone on the sea-coasts; and to these three places he gathered all the inhabitants, leaving the rest of Messenia to the mercy of the Spartans. They, on the other hand, looked on the war as now in a manner finished; for which reason they divided the lands among their citizens, and caused them to be carefully cultivated, while they besieged Era. But Aristomenes quickly convinced them that the war was far from being over: he chose out of all the Messenians 300 men, with whom he ravaged all the adjacent country; carried off a prodigious booty; and, when Messenia could no longer supply the wants of his garrison, penetrated into Laconia, and bore away corn, wine, cattle, and whatever else was necessary to the subsistence of his countrymen shut up in Era: so that at last the Spartans were constrained to issue a proclamation, forbidding the cultivation, not only of the Messenian territory in their hands, but also of Laconia in its vicinity; whereby they distressed themselves more than their enemies, inducing at last a famine in Sparta itself, which brought with it its usual attendant, sedition. Here again all things had gone wrong, if the wisdom of the poet Tyrtæus had not supported the Spartan courage; nor was it without much difficulty that he influenced them to continue the blockade of Era, and to maintain a flying camp for the security of the country.

Aristomenes, in spite of all these precautions, committed terrible depredations with his small corps of

300 men. Amongst other places which he plundered, the city of Amyclæ was one; from whence he carried not only a great quantity of riches, but also many carriages laden with provisions. The kings of Sparta lying with their troops in its neighbourhood, as soon as they heard of this expedition, marched after Aristomenes with the utmost diligence; and, as the Messenians were encumbered with their booty, came up with them before they could reach Era. In this situation of things, Aristomenes, prompted rather by despair than prudence, disposed his troops in order of battle; and, notwithstanding they were so few, made a long and vigorous resistance against the whole Lacedæmonian army. At length, however, numbers prevailed: the greatest part of the Messenians were slain on the spot; and Aristomenes, with about 50 of his men who survived the slaughter, were taken prisoners; that chief having received so many wounds, that he was senseless when they carried him away. The Lacedæmonians expressed the loudest joy at the sight of this illustrious captive; who for so many years, by his single abilities, had enabled his exhalted country to defend itself against the the whole force of Sparta. When he was recovered of his wounds, they decreed him and all his fellow-prisoners to be thrown together into a deep cavern, which was the common punishment of the lowest kind of offenders. This judgment was executed with the utmost severity, excepting that Aristomenes had leave to put on his armour. Three days he continued in this dismal place, lying upon and covered over with dead bodies. The third day, he was almost famished through want of food, and almost poisoned with the stench of corrupted carcases, when he heard a fox gnawing a body near him. Upon this he uncovered his face, and perceiving the fox just by him, he with one hand seized one of its hind-legs, and with the other defended his face, by catching hold of its jaw when it attempted to bite him. Following as well as he could his straggling guide, the fox at last thrust his head into a little hole; and Aristomenes then letting go his leg, he soon forced his way through, and opened a passage to the welcome rays of light, from which the noble Messenian had been so long debarred. Feeble as he was, Aristomenes wrought himself an outlet with his nails; and travelling by night with all the expedition he could, at length arrived safe at Era, to the great joy and amazement of his countrymen. When this news was first blazed abroad, the Spartans would have had it pass for a fiction; but Aristomenes soon put the truth of it out of doubt, by falling on the posts of the Corinthians, who, as allies of the Spartans, had a considerable body of troops before Era. Most of their officers, with a multitude of private men, he slew; pillaged their camp; and, in short, did so much mischief, that the Spartans, under the pretence of an approaching festival, agreed to a cessation of arms for 40 days, that they might have time to bury their dead. On this occasion, Aristomenes for the second time celebrated the *hecatomphonia*, or the sacrifice appointed for those who had killed 100 of the enemy with their own hands. He had performed the same before and after his second battle; and he lived to do it a third time: which must appear wonderful to the reader, when he is informed, that, notwithstanding this truce, certain Cretan archers in the service of the Spar-

Messenia. tans seized Aristomenes as he was walking without the walls, and carried him away a prisoner. There were nine of them in all; two of them immediately flew with the news to Sparta, and seven remained to guard their prize, whom they bound, and conducted to a lone cottage inhabited only by a widow and her daughter. It so fell out, that the young woman dreamt the night before, that she saw a lion without claws, bound, and dragged along by wolves; and that she having loosed his bonds, and given him claws, he immediately tore the wolves to pieces. As soon as Aristomenes came into the cottage, and her mother, who knew him, had told her who he was, she instantly concluded that her dream was fulfilled; and therefore plied the Cretans with drink, and, when they were asleep, took a poinard from one of them, cut the thongs with which Aristomenes was bound, and then put it into his hands. He presently verified her vision, by putting all his guards to death; and then carried her and her mother to Era, where, as a reward for her service, he married the young woman to his son Gorgus, then about 18 years of age.

When Era had held out near eleven years, it fell into the hands of Sparta by an accident: the servant of one Empiramus, a Spartan commander, driving his master's cattle to drink at the river Neda, met frequently with the wife of a Messenian, whom he engaged in an amour. This woman gave him notice, that her husband's house was without the wall; so that he could come to it without danger, when the good man was abroad; and she likewise gave him intelligence when her husband was upon duty in the garrison. The Spartan failed not to come at the time appointed; but they had not been long in bed before the husband returned, which put the house into great confusion: the woman, however, secured her gallant; and then let in her husband, whom she received in appearance with great joy, inquiring again and again by what excess of good fortune she was blessed with his return. The innocent Messenian told her, that Aristomenes being detained in his bed by a wound, the soldiers knowing that he could not walk the rounds, had a grant to retire to their houses, to avoid the inclemency of the season. The Spartan no sooner heard this, than he crept softly out of doors, and hastened away to carry the news to his master. It so happened, that the kings were at this time absent from the camp, and Empiramus had the chief command of the army. As soon as he received this information, he ordered his army to begin its march, though it rained excessively, and there was no moon-light. The fellow guided them to the ford, and managed matters so well that they seized all the Messenian posts: yet, after all, they were afraid to engage; darkness, an high wind, heavy rain, together with the dread of Aristomenes, keeping them quiet in the places they had seized. As soon as it was light, the attack began; and Era had been quickly taken, if only the men had defended it; but the women fought with such fury, and by their mingling in the fray, brought such an accession of numbers, as made the event doubtful. Three days and two nights this desperate engagement lasted: at last, all hopes of preserving the city being lost, Aristomenes drew off his wearied troops. Early the fourth morning, he disposed the

women and children in the centre, the Messenian youth in the front and rear, the less able men in the main body: himself commanded the van; the rear-guard was brought up by Gorgus and Mantichus, the former the son of Aristomenes, the latter of Theocles, a Messenian of great merit, who fell with much glory in this attack, fighting valiantly in the cause of his country. When all things were ready, Aristomenes caused the last barrier to be thrown open; and, brandishing his spear, marched directly towards the Spartan troops, in order to force a passage. Empiramus, perceiving his intent, ordered his men to open to the right and left, and fairly gave them a passage; so that Aristomenes marched off in triumph, as it were, to Arcadia.

The Arcadians, when they heard that Era was taken, were very desirous of succouring their old confederates in this deep distress: they therefore intreated their king Aristocrates to lead them into Messenia. But he, corrupted by the Lacedæmonians, persuaded them that it was too late; that the Messenians were all cut off; and that such a step would only expose them to the fury of the conquerors. When the thing appeared to be otherwise, and it was known that Aristomenes was on the frontiers of Arcadia, they went in crowds to carry him provisions, and to testify their readiness to afford him and those under his command all the assistance in their power. Aristomenes desired to be heard before a general assembly; which being accordingly convoked, he there opened one of the boldest and best-laid schemes recorded in history: he said, that he had yet 500 undaunted soldiers, who, at his command, would undertake any thing; that it was very probable most of the Spartans were employed in pillaging Era, and that therefore he determined to march and surprise Sparta; which appeared so sensible, that all the assembly loudly commended his great capacity and unshaken courage. Aristocrates, however, took care to betray him; having, by various pretences, retarded the execution of the project. The Arcadians, who began to suspect him, waited for and surprised the messengers as they came back. They took the letters from him, and read them openly in the assembly. The purport of them was, that they acknowledged his great kindness both now and in the battle; and promised, that the Lacedæmonians would be grateful. As soon as the letters were read, the Arcadians fell to stoning their king, frequently calling upon the Messenians to assist them; which, however, they did not, waiting for Aristomenes's orders; who, far from triumphing in this spectacle, stood still, with his eyes fixed on the ground, which he wet with his tears, his soul pierced with sorrow to see a crowned head so shamefully and so deservedly put to death. The Arcadians afterwards erected a monument over him, with an inscription to perpetuate his infamy. As for the Messenians under the command of Gorgus and Mantichus, they passed over into Sicily; where they founded the city of Messene, one of the most famous in the island. Aristomenes remained, however, in Greece; where he married all his daughters, except the youngest, to persons of great rank. A prince of Rhodes, inquiring of the oracle at Delphi whom he should espouse, that his subjects might be happy under his posterity, was directed

Messiah. directed to marry the daughter of the most worthy of the Greeks; which answer was immediately understood to point at the virgin daughter of Aristomenes. Her therefore he demanded, and received; Aristomenes accompanying him back to his dominions, where he formed a scheme of uniting the Lydians and Medes against the Spartans, resolving with this view to go into Media, and to the court of Sardis; but while he meditated these great things, death surprised him, and thereby freed Lacedæmon from the most formidable enemy she ever had.

MESSIAH, a word signifying one *anointed*, or installed into an office by unction. It was usual among the Jews to anoint kings, high-priests, and sometimes prophets, at the designation or installment of them, to signify emblematically the mental qualifications necessary for discharging these offices. Saul, David, Solomon, and Joash, kings of Judah, received the royal unction. Aaron and his sons received the sacerdotal, and Elisha the disciple of Elijah received the prophetic unction.—The name MESSIAH, *Anointed*, or *Christ* (*Χριστός*), was given to the kings and high-priests of the Jews. The patriarchs and prophets are also called by the name of *Messiahs*, or the *Lord's anointed*. See 1 Sam. xii. 3, 5. 1 Chron. xvi. 22. Ps. cv. 15.

But this name MESSIAH was principally and by way of eminence given by the Jews to their expected great Deliverer, whose coming they still vainly wait; and is a name the Christians apply to *JESUS Christ*, in whom the prophecies relating to the Messiah were accomplished. The sum of these prophecies is, That there should be a glorious person named *Messiah*, descended from Abraham, Isaac, and Jacob, who should be born at Bethlehem, of a virgin of the family of David, then in its decline, before the Jews ceased to be a people, while the second temple was standing, and about 500 years after Ezra's time; who, though appearing in mean circumstances, should be introduced by a remarkable forerunner, whose business it should be to awaken the attention and expectation of the people. That this illustrious person called *Messiah* should himself be eminent for the piety, wisdom, and benevolence of his character, and the miraculous works he should perform: yet that, notwithstanding all this, he should be rejected and put to death by the Jews; but should afterwards be raised from the dead, and exalted to a glorious throne, on which he should through all generations continue to rule, at the same time making intercession for sinners. That great calamities should for the present be brought on the Jews for rejecting him: whereas the kingdom of God should by his means be erected among the Gentiles, and disperse itself even unto the ends of the earth; wherever it came, destroying idolatry, and establishing true religion and righteousness. In a word, That this glorious person should be regarded by all who believed in him as a divine teacher, an atoning sacrifice, and a royal governor: by means of whom God would make a covenant with his people, very different from that made with Israel of old; in consequence of which they should be restored to, and established in, the divine favour, and fixed in a state of perpetual happiness. See *JESUS Christ*, and CHRISTIANITY.

The Jews, as was already observed, still wait for the

coming of the *Messiah*, being infatuated with the notion of a temporal *Messiah*, who is to be a mighty conqueror, and to subdue all the world. Most of the modern rabbins, according to Buxtorf, believe that the *Messiah* is already come, but that he keeps himself concealed, and will not manifest himself because of the sins of the Jews. Some of the Jews, however, in order to reconcile those prophecies that seem to contradict each other as to the character and condition of the *Messiah*, have had recourse to the hypothesis of two *Messiahs*, who are yet to succeed each other; one in a state of humiliation and suffering; the other of glory, splendor, and power. The first, they say, is to proceed from the tribe of Ephraim, who is to fight against Gog, and to be slain by Annillus, Zech. xii. 10. The second is to be of the tribe of Judah, and lineage of David, who is to conquer and kill Annillus, and restore the kingdom of Israel, reigning over it in the highest glory and felicity.

Jesus Christ asserts himself the *Messiah*. In St John iv. 25. the Samaritan woman says to Jesus, *I know that when Messiah comes, who is called the Christ, he will tell us all things.* Jesus answered her, *I that speak to thee am he.*

There are several impostors, who have endeavoured to pass for *Messiahs*, as Christ himself predicted. J. Lent, a Dutchman, has written a history *De Pseudomessias*, "Of False Messiahs." The first he mentions was one Barcochab, who appeared under the empire of Adrian. The last was rabbi Mordecai, who began to be talked of in 1682. A little before him, viz. in 1666, appeared Sabbethai Sebi, who was taken by the Turks, and turned Mahometan.

MESSINA, an ancient, large, handsome, and strong city of Sicily, and in the Val-di-Demona, with a citadel, several forts, a fine spacious harbour, and an archbishop's see. It is seated on the sea-side, 110 miles east of Palermo, 260 south by east of Rome, and 180 south-east of Naples. E. Long. 15. 50. N. Lat. 38. 10. The public buildings and the monasteries were numerous and magnificent, and it contained about 60,000 inhabitants; the harbour is one of the safest in the Mediterranean, and extremely deep; the viceroy of Sicily resides here six months in the year; and it was a place of great trade in silk, oil, fruit, corn, and excellent wine, especially since it was declared a free port. This city in the beginning of the year 1783 suffered most dreadfully by the earthquakes, which shook great part of Calabria and Sicily to their foundations, overturned many rich and populous towns, and buried thousands in their ruins: (see CALABRIA and EARTHQUAKE.)—The following account of Messina, as it stood before the above period, is extracted from Mr Swinburne's *Travels in Sicily*.

A large chain of mountains presses upon the shore, and part of the city stands upon elevated ground. The mountains are many of them nobly wooded; the hills before them finely chequered with groves and fields. As the town runs in a sweep along the edge of a declivity, every building of consequence is seen to advantage, while the less noble parts are hidden by the Palazzata. This is a regular ornamental range of lofty houses, with 19 gates, answering to as many streets: it follows the semicircular bend of the port for one mile and five poles, and would have been the handsomest line of buildings in Europe had the design been

Messiah,
Messina.

Messina.

completed; but a considerable part of the extent is not finished, except merely in the front wall, and that seems to be in a very ruinous condition. Philibert Emmanuel of Savoy, viceroy of Sicily, in 1622 began this princely work. Before it is a broad quay, decorated with statues and fountains; ships of any burden can moor close to the parapet in great depth of water. At the west extremity is a small fort and a gate; the other end is closed by the governor's house and the citadel, a modern pentagonal fortress, built on the point where the isthmus or *braccio di San Raniero* issues from the main land. On this slip of low ground, which with the Palazzato forms the circular harbour of Messina, are placed the light-house (*lazaretto*), and on the point the old castle of St Salvatore. The circumference of the port is four miles: it probably owes its formation to an earthquake, which opened an immense chasm, and then filled it with water. Near the light-house is a kind of whirlpool in the sea, shown as the Charybdis of the ancients.

The inner part of Messina is dirty, though it contains a considerable number of neat churches and large substantial dwellings. The cathedral is Gothic, enriched with Saracenic mosaics on the altars and shrines; the front of the high altar is particularly splendid: Gagini has embellished the pulpit and some tombs with excellent specimens of his art.—In the treasury of this church is preserved the palladium of Messina, a letter from the Virgin Mary to its citizens (A). This is the title upon which the Messinese build their pretensions to pre-eminence over the whole island, nay over the whole world; to its virtues and patronage they attribute every piece of good fortune, and to their own unworthiness all sinister events that have befallen them. The authenticity of this epistle has been seriously impugned, and of course vigorously defended by many Sicilian divines and disputators.

N^o 211.

There is another church in this city that deserves particular notice, not so much on account of its architecture or ornaments, as for its being the last refuge of the Greek liturgy, which was once the predominant service of the island, but gradually abolished by different conquerors. It is dedicated to the Virgin Mary de Grapheo, or of the *Letter*, which denomination may perhaps have furnished Lascaris with the idea of his letter. It is known at present by the name of *la Costolica*. According to the Greek canons, the entrance of monastic churches was reciprocally forbidden to each sex, and the cathedrals were the only places of worship where a daily sacrifice was offered up by the bishop and clergy, and where both men and women were present at the same time, but in different parts of the church. From this general admittance the building acquired the title of *Catholic* or *universal*.

Messina is all paved with lava, cut into large flags of two feet square: a material which the vicinity of lavas render it easy to procure, and which being very hard resists friction better than any other.

During a series of ages, notwithstanding the various revolutions and calamities to which it has been exposed, this city has still maintained its original situation; while most other cities have shifted their ground more or less from the place where they were first founded. But its situation enjoys advantages which have still tempted such of its inhabitants as escaped from the ravages of war and the desolation of earthquakes, to prefer it to every other spot, however delightful or secure. It is of very ancient origin; it has been under many different races of monarchs; and its name has been repeatedly changed: It has been at different times called *Zancle*, *Mamerina*, *Messana*. Its first name *Zancle*, which in the old language of Sicily meant "a sickle;" alluding, as some authors suppose, to the form of the port; or, according to others, to the

(A) The story is as follows: After St Paul had made some stay at Messina (a circumstance of his travels unnoticed by St Luke), the Messinese prevailed upon him to return to Jerusalem with an embassy of four persons sent by the city to the Virgin Mary. Their excellencies were graciously received by her, and brought back a letter written with her own hand in the Hebrew tongue, which St Paul translated into Greek. By the irruption of the Saracens this invaluable treasure was lost, and utterly forgotten till the year 1467, when Constantine Lascaris, a refugee Greek, found a copy of it, and turning it into Latin, made it known to the citizens, and then to all the Catholic world. Its authenticity is now so well established at Messina, that Regna the historian candidly acknowledges, that whoever was to confess even a doubt on the subject in that city would be treated as an infidel.

This curious epistle is conceived in these terms:—*Maria Virgo Joachim filia, Dei humillima Christi Jesu crucifixi Mater, ex tribu Judæ stirpe David, Messanenibus omnibus salutem, et Dei patris omnipotentis benedictionem. Vos omnes fide magna legatos ac nuncios per publicum documentum ad nos misisse constat. Filium nostrum Dei genitum Deum et hominem esse fatemini, et in cælum post suam resurrectionem ascendisse, Pauli apostoli electi prædicatione mediante viam veritatis agnoscetes. Ob quod vos et ipsam civitatem benedicimus cujus perpetuam protectricem nos esse volumus. Anno filii nostri XLII. Indiæ. I. III. Nonas Junii, luna XXVII. feria V. ex Hierosolymis.*

Thus translated:—"The Virgin Mary, daughter of Joachim, most humble mother of God, Jesus Christ crucified, of the tribe of Juda and the family of David, health and the blessing of God the Father Almighty to all the people of Messina. Out of the abundance of your faith, you have, in consequence of a public deliberation, sent a deputation to me; and since you acknowledge that my Son is both God and man, and that he ascended into heaven after his resurrection, as you have learned from the preaching of St Paul the apostle, I give my blessing to you and all your city, and agree to become your protectress. In the 42d year of my Son, the 1st of the Indiction, the 3d day of June, and the 27th of the moon, at Jerusalem."

Not to dwell upon the astronomical blunders in these dates, let it suffice to observe, that Lascaris was not aware that Denis the Little, a Syrian monk in the 6th century, was the first who made use of the era that commences at our Saviour's birth.

Messina. the fertility of the country. Allured by the advantages of its situation, the Cumæans, a commercial and enterprising people, invaded the island and drove the Siculi from this settlement; they were in their turn overpowered by a band of Samian adventurers, who made way for a colony of citizens of Messene, and under these masters it changed its name to *Messana*. Their government was of short duration; for in the 289th year before Christ it was destroyed by the Mamertines, a warlike unprincipled nation inhabiting the south part of Brutium. These soldiers being received into *Messana* on their return to Italy from Syracuse, where they had served as mercenaries in the army of Agathocles, took an opportunity of massacring the inhabitants and usurping their possessions. The city was now called *Mamertina*: and, in order to support themselves against the resentment of the Sicilian powers, the Mamertines implored the protection of the Romans, who, eager to extend their dominion beyond the limits of Italy, and jealous of the growing power of Carthage, made no scruple to succour these assassins with a consular army. This step brought on the first Punic war. The Mamertines reaped no other fruit from the alliance but a more honourable degree of slavery; for such was the real nature of their connection with Rome, whatever name it might be disguised under.

Messina was, however, always distinguished by particular attentions and favours from the senate; and, excepting a short period during the wars of the triumvirate, appears to have tasted all the sweets of Roman prosperity, without partaking of the bitter draughts of adversity. Its fate, in the ruin of the empire, was similar to that of the rest of Sicily. In 829 Messina fell into the hands of the Saracens, but obtained very honourable terms of capitulation; for half the city was left to the Christians, where they were to be governed by their own laws, and profess their own religion undisturbed. In the other resided the bey of one of the five provinces into which the Arabian conquerors had divided the island. Notwithstanding this indulgence, Messina was the first to cast off the yoke in 1037, when George Maniaces landed an army of Greeks and Normans on the shore of the Faro. It afterwards held out against the whole Mussulman force, till the feeble state of a distracted empire shut out all hopes of assistance from Constantinople. This unfortunate city then opened its gates to the army of the caliph, and felt very severely the weight of his resentment: but it did not long groan under the yoke; for in less than 20 years Roger the Norman took it by surprise and delivered it from Mahometan oppression. During the crusade our Richard Cœur de Lion and Philip Augustus king of France wintered here in their way to Palestine; a sojourn marked by continual quarrels, conflagration, and bloodshed. The Messinese were particularly tardy in entering into the national conspiracy of 1282, but afterwards exceeded the rest of the insurgents in deeds of cruelty: This and the importance of their situation singled them out for the first objects of Charles's vengeance. He invested their city very closely, and declared so openly his determination to refuse all terms whatever to the besieged, that they saw no hopes of safety but in an obstinate defence. Their courage, perseverance, and sufferings,

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were excessive; at length their strength and resources began to fail rapidly, and every circumstance seemed to denounce their speedy destruction, when Roger Lauria appeared off the harbour with the Arragonian fleet, forced the king to retire with precipitation across the straits, and in his fight defeated and destroyed his naval armament. Robert, grandson of Charles I. also made a fruitless attack; but in the disturbed reign of Frederick III. Messina was delivered up to Louis king of Naples and his consort queen Joan, who entered it in triumph. In a few years it returned to its former possessors. The year 1672 was remarkable for the revolt of the Messinese.—They threw off the Spanish yoke, and swore allegiance to Louis XIV. king of France. They were for some time vigorously assisted by the French; but before the Spaniards had gained the least advantage to excite any hopes of recovering so valuable a possession, Louis found himself necessitated from motives of political interest to desert his new subjects, and leave them to the mercy of their old incensed masters. The horror of being thus abandoned, and the chastisement inflicted by Spain, broke the fierce spirit of the Messinese; they were still stunned with the remembrance and effects of this blow, when the plague in 1743 was introduced from the Levant and swept away more than half the inhabitants. From this chain of calamities, the opulence, trade, and population of Messina, have been gradually sinking; and unless very favourable circumstances happen, will every year fall lower. The number of its inhabitants does not now exceed 30,000.

The following particulars are added from M. Houel, who visited this city since the late earthquakes, which completed its destruction.

On the front of the cathedral there is a square, which, though not regular, is far from being mean. This was not the largest square in Messina before its overthrow; but it was the most elegant, the most splendidly adorned, and the best frequented. There stands in this square an equestrian statue of Charles II. of Spain, in bronze, which has been spared by the earthquake. It stands on a marble pedestal, in the middle of the square. Opposite to this statue is an elegant marble fountain, ornamented with a variety of figures, representing men and other animals, all of them spouting out water in great abundance; which used, in summer, to spread an agreeable and refreshing coolness over the square, that induced company to assemble here. Seven streets terminated here. The cathedral forms a part of the square. It is dedicated to the blessed Virgin; the occasion of which has been already mentioned.

There is an anniversary feast celebrated in Messina, which is called *the feast of the Letter*. A lock of the Virgin's hair, which she sent to the Messenians at the same time with the letter, is carried through the city in procession in a crystal vessel. She made also a present of her picture to the Messenian deputies. It is placed over the tabernacle. None but the canons of the cathedral are permitted to touch, or take up on their shoulders, the silver shrine in which the crystal vessel with the Virgin's hair is deposited. Eight of those canons, with mitres on their heads, bear this shrine in the procession. The canopy suspended over it is supported by six senators in their robes. The

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picture and the hair are shown to strangers. This procession and the other religious ceremonies of this festival are followed by horse races. The spirits of the people being already elevated by their religious exercises, they engage with amazing eagerness in these and the other diversions with which they are accompanied: a tumultuous joy reigns over the city; and the evening concludes with illuminations and fire-works. The ships in the harbour pay the citizens the compliment of entertaining them with a discharge of their guns on the occasion.

Through a square called *the Square of the Great Hospital*, runs a large and impetuous torrent, the *Porto delle Legni*. It is precipitated from those lofty mountains which overlook this city on the south side. The channel which it has cut out for itself is at times entirely full. It would, on such occasions, overflow the square and other parts of the city, were it not confined by walls which have been built on both sides to prevent such accidents.—Another stream of a similar origin, called the *Torrent of La Bocchetta*, runs through another part of the city; it is also confined within the walls to prevent it from overflowing.

The *Square of St John of Malta* is one of the largest in Messina. In the middle of this square is a fine marble fountain, ornamented with a variety of sculptured figures and jets d'eau. Beside the fountain there used to stand a large reservoir for horses to drink out of.

In the time of the annual festivals, there used to be exhibited on the waters of the reservoir a galley, or rather a fictitious representation of a galley, with galley-slaves, soldiers, officers, and a commander on board, all in arms, and the galley properly equipped as a ship of war. This galley was decorated with great art; and by night the masts, and every other suitable part, were hung with lamps, which illumined it in a very splendid manner. Every thing around was so artificially disposed, that when the fire-works were played off, the spectator was led to think, though he perceived only one galley, that the noise which he heard was produced by a naval combat; and that the other ships were concealed from his view by the smoke occasioned by the guns and fire-works. This, when properly conducted, was a noble spectacle. The senate repaired thither from the cathedral, attended with a guard and a numerous company. In one carriage sat six senators, the governor of the city, and sometimes the archbishop. It was exceedingly large, and drawn by six white horses very richly harnessed. Other carriages followed, with the train who attended the governor and the senators.

Almost all festivals owe their origin to some extraordinary event, or some singular story either true or false. It is said, that when the splendor with which the feast of *the assumption de la Bara* was celebrated at Messina, first began to attract foreigners to the city, on that occasion such crowds repaired thither as to alarm the inhabitants with the fears of a famine: But one year, when the number of strangers was greater than usual at the time of this festival, the magistrates were very much at a loss how to supply them with provisions; and at length, every other resource failing, no hopes of relief remained but from the kindness of the Blessed Virgin. Fervent prayers were addressed to their patroness: and next morning by day-break three

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brigantines appeared entering the harbour with full sails. They proved to be loaded with corn. It was eagerly purchased: and the people of the city hastened to appease their hunger. But when they came after refreshing themselves to pay the corn-merchants their money, neither ships nor merchants could be found. After their first emotions of surprise had subsided, they naturally concluded that such a seasonable supply must undoubtedly be a present from the Virgin, who, being pleased with the zeal of her Messenian votaries, and desirous to prevent the concourse of strangers who attended the festival from diminishing, had interposed in this miraculous manner to save them from the distresses of famine. A new festival was celebrated in gratitude to their generous benefactress. Three small vessels of silver were made, and dedicated to the Virgin in memory of the event; and these are at present used as lamps in the cathedral. The senate likewise decreed, that the clergy should pay annually a small tax, to be laid out in constructing a small galley to swim on the fountain, and in defraying the expences of the fire-works. The profits of the clergy are so considerable on the occasion of the festival, that they may be supposed to pay the tax with great cheerfulness.

In Messina, as in the other cities of Sicily, the women wrap themselves in a large black mantle above the rest of their dress. The stuffs are richer or plainer according to rank and circumstances. People who are not rich enough to have fine cloaths of their own, hire them at so much an hour. There are women who make a livelihood by lending out their cloaths. The mantle covers the wearer from head to foot.—It reduces the old and the young, the ill-shaped and the handsome, pretty much to an equality in point of appearance. This must naturally appear very unfavourable to the influence of beauty. But yet, on proper occasions, at church or in a public walk, the ladies of Messina find means to open and adjust the mantle so as to display all their beauties of face and shape, and to attract the affections of lovers, perhaps more powerfully than if their dress were suited to display their charms in a more ostentatious manner.

Between Messina and the tower of Faro there stands a small church called the *Madona of the Grotto*. It was anciently a temple of a round structure, and ornamented with columns like the temple of the sun at Rome. Modern columns now supply the place that was occupied by the ancient. There are large niches in the rock adjoining to the temple, which are thought to be of equal antiquity. These contain no sculptured figures; but in Pagan times they might possibly contain some.

Messina being situated between mount *Ætna* and the gulph of *Charybdis*, and being likewise at no great distance from the volcanoes of *Lipari* and *Stromboli*, must have been in all ages liable to suffer by earthquakes. Such terrible events, however, appear to have been more unfrequent in ancient than in modern times, and have actually alarmed the present age oftener than any other. In the 1693 a fourth part of the cities of Sicily was destroyed by an earthquake. Messina merely felt the shock: all its buildings, however, suffered. In the year 1742 it suffered another equally violent. A plague which followed in 1743 retarded the repairs necessary after the earthquake. In the

year

Messina. year 1780 this city continued, for more than six months, to suffer from a new earthquake.

Were the state of the elements, previous to these dreadful events, carefully examined, it might perhaps be found to undergo certain changes which might be considered as prognosticating them.

The autumn of the year 1782 was unusually cold and rainy. Fahrenheit's thermometer was often as low as 56 degrees. The succeeding winter was dry; and the mercury never fell under 25 degrees: And, what is uncommon in that season, storms were now and then observed to arise from the west. The pilots in the channel observed that the tides no longer rose at the usual periods, and the gulph of Charybdis raged with extraordinary fury.

On the 5th of February 1783, the air was heavy and calm; the sky obscured with thick clouds, and the atmosphere seemingly all in a flame. About half after twelve at noon, the earth began to shake with a dreadful noise. The shocks continually increased, and became at length so violent as to open the ground, and to overturn in two or three minutes a considerable part of the buildings.

A long white cloud appeared to the north-west; and soon after another, very dark, in the same quarter of the heavens. The latter in a moment spread over the whole horizon, and deluged the city with rain and hail, accompanied with dreadful claps of thunder. The inhabitants fled in the utmost terror to the fields and the ships in the harbour.

From mid-day till five in the afternoon the earthquake continued almost without interruption. The shocks then became somewhat less frequent. The cries of the dying; the shrieks of those who were half-buried under the ruins; the wild terror with which others, who were still able, attempted to make their escape; the despair of fathers, mothers, and husbands, bereft of those who were dearest to them; then formed altogether a scene of horror, such as can but seldom occur in the history of the calamities of the human race. Amid that awful scene, instances of the most heroic courage and the most generous affection were displayed. Mothers, regardless of their own safety, rushed into every danger to snatch their children from death. Conjugal and filial affection prompted deeds not less desperate and heroic. But no sooner did the earthquake cease, than the poor wretches who had escaped began to feel the influence of very different passions. When they returned to visit the ruins, to seek out the situation of their fallen dwellings, to inquire into the fate of their families, to procure food and collect some remains of their former fortunes—such as found their circumstances the most wretched became suddenly animated with rage, which nothing but wild despair could inspire. The distinction of ranks, and the order of society were disregarded, and property eagerly violated. Murder, rapine, and lawless robbery, reigned among the smoking ruins.

About one in the morning another shock of the earthquake was felt, which overturned most of the houses that were still standing. Most of those whom want, or avarice, or humanity, still detained among the ruins, now shared the same fate with their friends whom the former shocks had buried under them.

The succeeding day scarce alleviated the distress of this dismal night: the few wretches who still survived found themselves destitute of every necessary. At length order was in some degree re-established; and in two days after every person was supplied at least with some small portion of the necessaries for subsistence.

None yet thought of returning to take up their abode among the ruins. The common people fixed their residence on the plain of Porto Salvo, near the town of Salleo. The nobles, magistrates, and merchants, took up their abode on another plain, on the other side of the stream Porta de Legno; the soldiers at Terra Nuova.

Some violent shocks which were again felt on the 7th of February and the 28th of March completed the destruction of the city. The corn magazines, however, escaped without damage; and the public ovens and the aqueducts were but little injured. From these facts it may perhaps be inferred, that had not the houses of Messina been, in general, hastily built at the first, and afterwards carelessly repaired, fewer of them would have been overthrown by the earthquake.

The neighbouring villages having suffered but little, were the first to relieve the remaining inhabitants of Messina in their distress. Maltese galleys for some days supplied necessaries to the poor and the sick with a generosity which merits the highest praise. They brought surgeons and whatever was needful for the cure of the wounded. The supplies sent by the king of France were refused, for what reason we know not. What money was needed for the support of the people was taken from the treasury of the city of Messina; for what the king of Naples sent was seized and spent by the garrison.

It is said that not more than 800 or 900 persons perished by this earthquake. The sea during that convulsion of the land was slightly agitated in the harbour. Farther out the sea was more violently agitated; but none of the ships in the harbour were dashed to pieces. The waters rose so high as to be injurious in a very considerable degree to Pharo, as well as along the coast of Scylla and Bagnara.

This earthquake was not of a momentary duration, like that by which Lisbon was destroyed, and like many others: for more than sixty days, from the 5th of February to the beginning of April, Messina continued to be shaken; and in that time felt more than 200 shocks. And ever after that period the alarm was again and again renewed. Not only the magistrates, the soldiers, and the people, but the priests likewise, with their tabernacle and altar, retired to the barracks. The nuns, too, deserted their cloister, and sought a retreat without the walls. Some of them confined themselves to the gardens of their convents; others mixed indiscriminately with the people.

The chief damage which the public buildings within the city suffered was the fall of the dome of the church of Purgatory. Only the walls were left standing: and even these had suffered considerably. One half of the steeple of the cathedral was beaten to the ground. The magazines of Porto Franco were likewise very much shattered. The fort of St Salvator, being built on an artificial foundation, the side next the sea is there fallen down; but on the other side, where it is

Messina
||
Metacarpus.

founded on a rock, it has stood unmoved by all the shocks of the earthquake.

On the 5th of February, when the earthquake was more violent than at any time afterwards, a strong smell of sulphur was felt. The earth was affected somewhat in the same way as if it had been borne upon a fluid; and seemed to reel with the shocks much like a ship tossed with the waves. This tremulous motion was felt all over Sicily; but towards Pharo it became weaker. On the following days the sky was cloudy; the mountains of Sicily and the shores of Calabria continued covered with a thick fog like smoke. North and north-east winds raged with the most violent impetuosity.

The disastrous year of this earthquake was scarce concluded, the chafms which it had opened in the ground were still yawning, and the poor inhabitants of the adjacent country still trembled with terror, when the elements again renewed their fury to ravage this miserable land.

On Tuesday the 6th of January 1784, about sunrise, the wind began to blow softly from the north-east. The sea gradually swelled, rose beyond its bed with rapid impetuosity, overflowed the quay of Messina, and lashed with its billows the ruins of the Palazzata. It loosened and displaced many of the stones of the mole, spread over the whole street, and attacked the pedestals of the statues which had been spared by the earthquake, and still stood firm among the ruins. The same furious wind which swelled the sea in so extraordinary a manner, ravaged the whole coast from Messina all the way to Syracuse.

MESSUAGE, *Messuagium*, in law, a dwelling-house, with some land adjoining assigned for its use. By the name of *messuage* may a garden, shop, mill, cottage, chamber, cellar, or the like, pass.—In Scotland, *messuage* denotes what is called in England the *manor house*, viz. the principal dwelling-house within any barony.

MESOPORPHYRON, a name given by the Greeks to the Roman *laticlave*; because that garment, being edged on each side, where it opened before, with purple, appeared when closed with two purple stripes down the middle. The same term was also applied to the *angusticlave*.

META, in the Roman circus, was a pile of stones of a pyramidal form, intended as a boundary of the *stadium*, or chariot-course.—When the meta was passed the seventh time, the race was concluded. The greatest art and management were required in avoiding the meta, and yet going as near it as possible. If they went too near, they were in the greatest danger of breaking the chariot to pieces; and if they took too large a circuit in the turn, they gave their rivals an opportunity of getting within them, besides losing a great deal of ground. The boundary of the Grecian *stadium*, or course, was called *τιγος, τιγμα, γραμμη* and *αρχα γραμμη*; to which last name Horace probably alludes in calling death, "*ultima linea rerum*."

The *meta* at Rome were first of wood, afterwards of stone; but the emperor Claudius made them of gold, or rather gilded them. In the Roman circus there were two *meta*, one at the entrance of the course, and the other at the end of it. An egg was placed upon the top of the *meta*.

METACARPUS, or METACARPUM, (from *μετα*

behind, and *καρπος*, *hand*), in anatomy, that part of the hand between the wrist and the fingers. See ANATOMY, n° 55.

METAGITNION, the second month of the Athenian year, answering to the latter part of our July and the beginning of August, and so called from *metagitnia*, a festival in honour of Apollo, which was kept in it. The Boeotians called this month *panemus*, and the Syracusans, *carnius*.

METAL, in natural history, a simple, ponderous, shining, fixed, opaque body, that fuses and becomes fluid by fire, and by cold coagulates and hardens into a solid mass, capable of being distended under the hammer. See METALLURGY, and CHEMISTRY.

METAL, in heraldry. There are two metals used in heraldry, by way of colours, viz. gold and silver, in blazon called *or* and *argent*.

In the common painting of arms these metals are represented by white and yellow, which are the natural colours of those metals. In engraving, gold is expressed by dotting the coat, &c. all over; and silver, by leaving it quite blank.

It is a general rule in heraldry, never to place metal upon metal, nor colour upon colour: so that if the field be of one of the metals, the bearing must be of some colour; and if the field be of any colour, the bearing must be one of the metals.

METALS, *Solution of*. See CHEMISTRY-Index.

On this subject Mr Keir has some curious observations in the Philosophical Transactions for 1790. He takes notice, that the word *solution* has two meanings; one expressive of the act of dissolving, as when we say that "*solution* is a chemical operation;" and the other, when it is put for the substance dissolved in the acid, as "*a solution of silver in the nitrous acid*." To avoid confusion, therefore, he uses the word *solution* to express the substance dissolved, together with its solvent; *dissolution* being the term made use of when the act of dissolving is meant. He continues the use of the terms *phlogisticated* and *dephlogisticated* to express certain states of the acids, but without reference to theory of any kind.

In dissolving metals, our author observes, that the properties of the several acids have been investigated with considerable success; and even one compound, viz. that of spirit of nitre and spirit of salt, commonly called *aqua regis*, is well known on account of its quality of dissolving gold. A vast field, however, yet remains for examination in the other acids, whether mixed together, or possessing various degrees of concentration, temperature, or phlogistication. Thus, though no two substances are more frequently in the hands of chemists than vitriolic acid and nitre, yet the properties of the mixture had not been investigated before Mr Keir made his experiments; and upon trial he found, that this mixture possessed certain properties which neither the vitriolic nor nitrous acids singly possess. The results of his experiments on this subject are as follow.

1. In a long-necked retort containing 1400 grain measures, 100 grains of oil of vitriol of the specific gravity of 1.844 were put along with 100 grains of pure nitre, and the salt dissolved in the acid by means of a water-bath. On applying a boiling heat, the silver began to dissolve, and the solution assumed a purple

or

Metagit-
nion,
Metal.

Metal. or violet colour; but no air was extricated. An end was put to the operation (by the rushing in of the water used in the pneumatic apparatus applied to the retort) when 39 grains of silver had been dissolved.

2. To 100 grains of nitre previously dissolved in an equal quantity of vitriolic acid, 200 grains of standard silver were added; of which 92 grains were dissolved without the production of any air or gas: but upon pouring in 200 grains of water into the retort, a violent effervescence took place, and 3100 measures of nitrous gas were thrown off; and on adding 200 grains more, a farther emission of 600 grain measures ensued; but no more was emitted on the addition of more water, nor did any farther dissolution of the metal take place than two grains. The same phenomena took place in various proportions, according to the different quantities of acid and metal made use of.

On substituting tin for silver, none of the metal was dissolved or calcined by mixtures in the proportion of 200 grain measures of oil of vitriol to as much nitre, nor by 200 of the vitriolic acid to 150 of nitre: but with a proportion of 200 measures of the acid to 100 grains of nitre, the tin soon began to be acted upon, and diffused through the liquor; but no gas was extricated till the digestion had been continued in boiling water for two hours. The tin was still only calcined, not dissolved; 8500 grain measures of nitrous gas were extricated, and 73 grains of the metal reduced to a white powder. On pouring into the retort 200 grains of fresh water, a new effervescence took place betwixt the water and white powder, by which 4600 grain measures of nitrous gas were thrown off. The action of the menstruum was greatly promoted by augmenting the quantity of oil of vitriol, and adding water to the mixture.

By this mixture quicksilver was calcined to a grey powder, nickel was also partly calcined and partly dissolved; but no other metal was much affected, tho' the surfaces of some of them were tarnished. The mixtures themselves were very apt to congeal, especially where there was a large proportion of nitre; and their properties are much altered by the addition of water. Thus, in their concentrated state, they do not act upon iron; but by adding water, it acquires the property of acting upon that metal, and in different degrees according to the quantity of water added. Thus, by adding two measures of the compound acid to one of water, the liquor is rendered capable of calcining iron, and forming with it a white powder, but without any effervescence. An equal measure of water produces effervescence; and with a larger proportion of water the iron acquires a yellow or brown colour, such as phlogisticated nitrous acid acquires from iron, or communicates to a solution of martial vitriol in water. Dilution with water renders this compound acid capable of dissolving copper and zinc, neither of which it will touch in its concentrated state.

From this property of the compound acid not dissolving copper, but very readily silver, we have an easy method of separating the two metals from each other. This might be useful in many cases; but is particularly so in Birmingham, where great numbers of copper vessels covered with silver are manufactured. Thus there are always a great number of cuttings or

small bits called *scraps*, which are of no use but to separate the two metals from one another. The easiest method of doing this is an object of some consequence. Two methods have been generally practised for this purpose: one is by melting the whole mass of metal with lead, and separating them by means of eliquation and testing; the other is by dissolving both metals in vitriolic acid, and then separating the solution of copper from the vitriol of silver. The disadvantage of the former method is, the quantity of lead and copper wasted; and of the latter, that of vitriolic acid. The virtues of a mixture of oil of vitriol and nitre were some time ago communicated by Mr Keir to an artist at Birmingham; and it is now generally used there to effect the separation of the two metals. The method of using it is very easy; nothing more being requisite than to put the pieces of plated metal into a glazed earthen pan, and to pour upon them some of the acid liquor, which may contain about one pound of nitre to eight or ten of oil of vitriol. Stir them about, and assist the action by an heat from 100 to 200 of Fahrenheit's scale. When the liquor is nearly saturated, the silver may be precipitated in the form of *luna cornea* by common salt; or it may be obtained in its metallic form by adding to the liquor some pieces of copper, and as much water as will enable it to act upon them. He is of opinion, that the menstruum may be useful in all separations of silver from other metals. The name he seems to wish to impose upon it is *aqua regina*. The following are the conclusions drawn from the experiments on these mixtures by our author.

1. A mixture of the vitriolic and nitrous acids dissolves silver plentifully.

2. It acts upon tin, and mostly calcines it, as well as mercury and nickel; having little or no action upon other metals.

3. The quantity of gas produced while the metal is dissolving, is greater, relatively to the quantity of the metal dissolved, when the proportion of nitre to the vitriolic acid is small, than when it is large; and when the metals are dissolved by mixtures containing much nitre with a small production of gas, the solution itself, or the metallic salt formed in it, yields abundance of gas when mixed with water.

4. Dilution with water renders the concentrated mixture less capable of dissolving silver, but more so of acting upon other metals.

5. This mixture of highly concentrated vitriolic and nitrous acids, acquires a purple or violet colour when phlogisticated, either by the addition of inflammable substances as sulphur, or by its action on metals, or by very strong impregnation of oil of vitriol with nitrous gas.

6. By means of this phlogistication the mixture acquired a property of dissolving, though in small quantities, copper, iron, zinc, and regulus of cobalt.

7. Water expels a vast quantity of nitrous gas from a concentrated mixture of vitriolic acid and nitre impregnated with it; but this fluid unites with a mixture of oil of vitriol and nitre without any considerable effervescence.

By adding to the mixture of oil of vitriol and nitre a solution of common salt, a very powerful *aqua regis* is formed, capable of dissolving gold and platina; and which,

Metal.

Metal.

which, though perfectly free from all metallic matter, acquires at once a deep yellow colour. Dry common salt added to the concentrated mixture produces an effervescence, but, no yellow colour.

METALEPSIS. See ORATORY, n° 59.

METALLISATION, the natural process by which metals are formed in the bowels of the earth. See METALLURGY, sect. i.

Metalepsis.
Metallisation.

M E T A L L U R G Y.

METALLURGY, according to Boerhaave, comprehends the whole art of working metals, from the glebe or ore to the utensil; in which sense assaying, smelting, refining, parting, smithery, gilding, &c. are only branches of metallurgy. But, in the present work, Gilding, Parting, Purifying, Refining, Smithery, &c. are treated under their proper names. With others, therefore, we have chosen to restrain *Metallurgy* to those operations required to separate metals from their ores for the uses of life. These operations are of two kinds: the smaller, or Assaying; and the larger, or Smelting. But a particular descrip-

tion of the ores themselves seemed likewise necessary to be given; and to this place, too, we have referred a general account of metals, metallisation, mines, and ores, as a proper introduction to the subject. Hence the following division into three parts. The *first* treating, 1. Of metals and metallisation. 2. Of mines and ores in general. 3. Of the pyrites. 4. Of the assaying of ores in general. The *second*, Of the particular ores, and the methods of assaying them. The *third*, Of smelting of ores, or the methods of extracting metals from large quantities of ores for the purposes of commerce or manufacture.

P A R T I.

SECT. I. Of Metals and Metallisation.

UNDER the general name *metal*, we comprehend here not only the metals properly so called, but also the *semimetals*, or all matters which have the essential metallic properties which we shall here recount. Thus the word *metal* and *metallic substance* will be synonymous in this article.

Metallic substances form a class of bodies, not very numerous, of very great importance in chemistry, medicine, arts, and the ordinary affairs of life. These substances have very peculiar properties, by which they differ from all other bodies.

The natural bodies from which metals differ the least are, earthy and pyritous matters, on account of their solidity and density. Metals and stones are, nevertheless, very different; the heaviest stones which are unmetallic being much lighter than the lightest metals. A cubic foot of marble weighs 252 pounds; and an equal bulk of tin, the lightest of metals, weighs 516 pounds. The difference is much greater when the weight of such stone is compared with that of gold, a cubic foot of which is 1326 pounds.

Opacity is another quality which metals possess eminently, the opacity of metals being much greater than that of any unmetallic substance.

This great opacity of metals is a consequence of their density; and these two properties produce a third, peculiar also to metals, namely, a capacity of reflecting much more light than any other body: hence metals whose surfaces are polished, form mirrors representing the images of bodies more clearly than any other matter. Thus looking-glasses produce their reflection merely by the silvering, which is a covering of metal upon their surfaces. To this reflective property metals owe their peculiar lustre, called the *metallic lustre*.

Although the several metallic substances differ considerably in hardness and fusibility, we may say in ge-

neral, that they are less hard and less fusible than pure earths.

Metals cannot unite with any earthy substance, not even with their own earths, when these are deprived of their metallic state: hence, when they are melted, they naturally run into globes, as much as the absolute gravity of their mass, and their pressure upon the containing vessels, will allow. Accordingly, the surface of a metal in fusion is always convex. A metal in that state always endeavours to acquire a spherical form, which it does more perfectly as the mass is less. This effect is very sensible in quicksilver, which is nothing but a metal habitually fluid or fused. A mass of several pounds of mercury, contained in a shallow wide-mouthed vessel, is so spread out, that its upper surface is almost flat, and the convexity is not very sensible but at its circumference: on the contrary, if we put very small masses of mercury into the same vessel, as, for instance, masses weighing a grain each, they become so round as to seem perfect globes. This effect is partly occasioned by the inaptitude of metals to unite with the vessels containing them when in fusion, by which quality the whole affinity which subsists betwixt the integrant parts of these metals is capable of acting; and partly also by this affinity, which disposes the integrant parts to come as near to each other as they can, and consequently to form a sphere.

This property is not peculiar to melted metals, but to all fluids, when contiguous to bodies solid or fluid, with which they have no tendency to unite. Thus, for instance, masses of water upon oily bodies, or oily masses upon bodies moistened with water, assume always a form so much nearer to the spherical as they are smaller. Even a large drop of oil poured upon a watery liquor, so that it shall be surrounded with this liquor, becomes a perfect sphere.

All metals are in general soluble by all acids; but often these solutions require particular treatment and circumstances, which are mentioned under CHEMISTRY. With acids, they form a kind of neutral salts, which have

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have all more or less causticity. The affinity of metals is less than of absorbent earths and alkaline salts to acids; and therefore any metal may be separated from any acid by these substances.

Alkaline salts are capable of acting upon all metallic substances, and by proper management will keep them dissolved.

Metals may in general be united with sulphur and liver of sulphur. With sulphur they form compounds resembling the peculiar substance of ores, which are generally nothing else than natural combinations of sulphur and metal. Metals have less affinity with sulphur than with acids; hence sulphur may be separated from them by acids. Some exceptions from these general rules, concerning the affinity of metals to sulphur and liver of sulphur, and concerning their separation from sulphur by acids, may be seen under the articles of the several metals. But these exceptions do probably take place, only because we have not yet found the method of surmounting some obstacles which occur in the ordinary methods of treating certain metals.

All metals may in general be united with each other, with which they form different alloys which have peculiar properties; but this rule also is not without some exceptions.

Metals have a strong affinity with the inflammable principle, and are capable of receiving it superabundantly.

Lastly, oily substances seem to be capable of acting upon all metals. Some metals are easily and copiously dissolved by oils; and perhaps they might all be found to be entirely soluble in oils, if the methods known in chemistry were tried for the accomplishment of these solutions.

The properties above mentioned agree in general to all metallic substances: but, besides the properties peculiar to each metal, some properties are common to a certain number of them; and hence they have been divided into several classes.

Those metallic matters which, when struck by a hammer, or strongly compressed, are extended, lengthened, and flattened, without being broken (which property is called *ductility* or *malleability*), and which also remain fixed in the most violent and long continued fire, without diminution of weight, or other sensible alteration, are called *perfect metals*. These perfect metals are three; *gold, silver, platina*.

The metallic matters which are ductile and fixed in the fire, to a certain degree, but which are destroyed by the continued action of fire, that is, changed into an earth deprived of all the characteristic properties of metals, are called *imperfect metals*. Of this kind are four; *copper, iron, tin, lead*.

The metallic substances which, as well as the imperfect metals, lose their metallic properties by exposure to fire, but which also have no ductility nor fixity, are distinguished from the others by the name of *semi-metals*. Of this class are seven; *regulus of antimony, bismuth, zinc, nickel, regulus of cobalt, regulus of arsenic, and of manganese*.

Lastly, *mercury*, which has all the general properties of metals, makes a class separate from the others; because in purity and gravity it is similar to the per-

fect metals, and in volatility to the semi-metals. Its fusibility also so far surpasses that of any other metallic matter, that it is sufficient to distinguish it from all, and to give it a distinct class. We have enumerated, therefore, in all, 15 metallic substances; four of which were unknown to the ancients, namely, platina, regulus of cobalt, of manganese, and nickel.

As chemists can compound bodies by being capable of separating the principles of such bodies, and even of re-uniting their principles so as to reproduce such compounds as they were originally; and as hitherto they have not been able to accomplish any such decomposition upon the perfect metals: hence, if all the other metallic substances were equally unalterable, we should be very far from having certain notions concerning metals in general: but if we except gold, silver, and platina, all the other metallic matters are susceptible of decomposition and of recomposition, at least to a certain degree; and experiments of this kind have thrown much light on the subject.

We may observe, that even if we had not been able to decompose any metallic substance, we might still, by reflecting on the essential properties of metals, discover sufficiently well the nature of their principles.

The solidity, the consistence, and especially the gravity, which they possess in a degree so superior to all other bodies, would not have allowed us to doubt that the earthy element, of which these are the characteristic properties, enters largely into their composition, and makes their basis.

The facility with which they combine with almost all inflammable matters, and with all those which have great affinity with phlogiston, such as acids; joined to their incapacity of being allayed with meagre matters that are purely earthy or purely watery, which have no disposition to unite with phlogiston; would also have furnished very strong motives to believe, that the inflammable principle enters largely into the composition of metals.

The destructible metals present exactly the same phenomena as all other bodies containing the inflammable principle do, in the state of combustion. When exposed to fire, without access of air, that is, in close vessels, they become red-hot, melt, or sublime, according to their nature: but they receive no alteration in their composition from fire applied in this manner, and they are afterwards found to be exactly in the same state as before. In this respect, they resemble perfectly all bodies which contain no other inflammable matter than pure phlogiston.

But when imperfect metals are exposed to fire, with access of air, as, for instance, under a muffle in a furnace which is made very hot, then they burn more or less sensibly, as their inflammable principle is more or less abundant, or more or less combined. Some of them, as iron and zinc, burn with a very lively and brilliant flame; but this flame is of the same nature as that of charcoal, of sulphur, of all bodies, the combustible principle of which is pure phlogiston, and is not in an oily state, that is, furnishes no foot capable of blackening.

The imperfect metals detonate with nitre, and their phlogiston is consumed by this method much more:

more quickly and completely than by ordinary calcination or combustion. Their flame is also much more lively and brilliant; and some of them, as iron and zinc, are used in compositions for fireworks from their very vivid and beautiful flame.

Nitre is alkalised by these metallic detonations exactly in the same manner as in its detonation by coals.

Lastly, imperfect metals being treated with acids which have an affinity with phlogiston, that is, with the vitriolic and nitrous acids, are deprived by these acids of a more or less considerable part of their inflammable principle; they give a sulphureous quality to vitriolic acid, and are even capable of producing sulphur with that acid.

Although the experiments now mentioned were the only proofs of the existence of an inflammable principle in metallic substances, they would be sufficient to establish it incontestably. But we shall see, when we continue to examine the phenomena attending the decomposition of metals, that those are not the only proofs.

If the inflammable matter which shows itself so evidently in the burning of metals, is really one of their constituent parts, their essential properties must be altered in proportion to the quantity of it taken from them: and this evidently happens upon trial: for the residuum of metallic matters, after calcination, departs from the metallic character, and approaches to the nature of mere earth. The opacity, brilliancy, ductility, gravity, fusibility, volatility, in a word, all the properties by which metallic substances differ from simple earths, diminish or entirely disappear, by taking from them their inflammable principle; so that when their calcination has been carried as far as is possible, they resemble mere earths, and have no longer any thing in common with metals. These earths can no longer be combined with acids or with metals, but are capable of uniting with pure earths. They are then called *calxes* or *metallic earths*. See CHEMISTRY.

We must observe concerning the decomposition of metals, 1. That when a small quantity of inflammable principle is taken from metals, only a small quantity of calx is formed, and the remaining part continues in the metallic state: hence, as the portion of calcined matter can no longer remain united with that which is destroyed, it separates in form of scales from the surface of the metal when the calcination has been performed without fusion, as generally happens to iron and to copper: or these scales float upon the surface of the melted matter when the calcination is performed during fusion, because the calx is specifically lighter than the metal; as happens to the very fusible metals, as tin, lead, and most of the semimetals.

2. The imperfect metals are not all equally easily and completely calcinable. In general, as much of their phlogiston may be easily taken from them, as is sufficient to deprive them of their metallic properties; but the remaining portion of their phlogiston cannot be so easily driven off. Some of them, as copper, resist the first calcination more than the rest; and others, as lead and bismuth, may be very easily calcined, but only to a certain degree, and retain always obstinately the last portions of their inflammable principle; lastly, others, as tin and regulus of antimony,

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may not only be easily and quickly calcined, but also much more completely. All the other metals partake more or less of these properties relating to their calcination. In general, if we except the labours of alchemists, which are not much to be depended upon, we have not yet made all the proper efforts to arrive at a perfect calcination of the several metallic substances; which, however, is absolutely necessary, before we can arrive at a complete knowledge of the nature of their earths, as we shall afterwards see.

When metallic earths have lost but little of their phlogiston, and are exposed to strong fire, they melt, and are reduced to compact masses, still heavy and opaque; although much less so than the metals, and always brittle and absolutely unmalleable. If the calcination has been more perfect, the metallic earths are still fusible by fire, but less easily, and convertible into brittle and transparent masses possessed of all the properties of glasses, and are accordingly called *metallic glasses*. These glasses do not possess any of the properties of their metals, excepting that they are specifically heavier than other glasses, that they are capable of being attacked by acids, and that the glasses of the semimetals are somewhat less fixed than unmetallic glasses. Lastly, when the calcination of metals has been carried to its greatest height, their earths are absolutely fixed, and unfusible in the fire of our furnaces, and possess no longer the solubility in acids by which metals are characterised.

These are the principal changes which metals suffer by losing their phlogiston. They are thus changed into substances which have no properties but those of earth. This is a certain proof that the inflammable principle is one of their constituent parts. But we have also other proofs of this important truth. The reduction of metallic calxes into metal, by the addition of phlogiston alone, completes the proof; and the whole forms one of the clearest and most satisfactory demonstrations in all the sciences. This reduction is effected in the following manner:

If the earth of a metal be mixed with any inflammable matter, which either is or can be changed into the state of coal, together with some salt capable of facilitating fusion, but which, from its quantity or quality, is incapable of receiving the inflammable principle; and if the whole be put into a crucible, and the fusion promoted by a fire gradually raised; then an effervescence will happen, accompanied with a hissing noise, which continues a certain time, during which the fire is not to be increased; afterwards, when the whole has been well fused, and the crucible taken from the fire and cooled, we shall find at the bottom, upon breaking it, the metal, the earth of which was employed for the operation, possessed of all the properties which it had before calcination and reduction.

We cannot doubt that this transformation of an earthy substance into a metal, is solely caused by the phlogiston passing from the inflammable matter to the metallic earth. For, first, in whatever manner and with whatever substance metallic earths be treated, they cannot be ever reduced into metals without a concurrence of some substance containing phlogiston. 2dly, The nature of the substance which is to furnish phlogiston is quite indifferent, because this principle is the same in all bodies containing it. 3dly, If, after the

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the operation, the substance furnishing the phlogiston be examined, we shall find that it has lost as much of that principle as the metallic earth has received. See PHLOGISTON.

The facts related concerning the decomposition and the recomposition of metals, prove incontestably that they are all composed of earth and phlogiston. But we do not yet certainly know whether these two be the only principles of metals. We might affirm this, if we could produce metals by combining phlogiston with some matter which is certainly known to be simple earth. But this hitherto has not been accomplished; for if we try to treat any earth, which has never been metallic, with inflammable matters, we shall perceive that the simple earths are not combinable with phlogiston so as to form metals. We shall even perceive that the metallic earths resist this combination, and are incapable of reduction into metal, when they have been so much calcined as very nearly to approximate the nature of simple earths.

These considerations, added to this, that we cannot easily conceive how, from only two certain principles, so many very different compounds as the several metallic substances are, should result, are capable of inducing a belief that some other principle is added to these two already mentioned in the composition of metals.

Many great chemists, and particularly Becher and Stahl, seem to be of this opinion. Chiefly from the experiments concerning the mercurification of metals, they believe that this third principle exists copiously in mercury; that it is of a mercurial nature; that it also exists in marine acid, to which it gives its specific character; that, by extracting this mercurial principle from marine acid, or any other body containing it copiously, and by combining it with simple earths, these may acquire a metallic character, and be rendered capable of receiving phlogiston, and of being completely metallified.

These chemists admit also, and with probability, a different proportion of metallic principles in the several metals; and believe, that particularly the principle which they call *mercurial earth*, exists more copiously and sensibly in certain metals than in others. The most mercurial metals, according to them, are mercury, silver, lead, and arsenic. Most chemists distinguish them from the other metals, which they call *white metals*, *lunar metals*, or *mercurial metals*.

All these considerations being united, and others too many to be mentioned, give some probability to the existence of the mercurial principle in metals. We must however acknowledge, that the existence of this principle is merely probable; and, as Stahl observes, is not nearly so well demonstrated as that of the inflammable principle: we may even add, that we have strong motives to doubt of its existence.

To produce metals artificially has justly been reckoned one of the most difficult problems in chemistry.

Metallic substances, although they resemble each other by their general properties, differ nevertheless from each other very evidently by the properties peculiar to each. Do these differences proceed from the different proportion, and from the more or less intimate connection of the inflammable principle with the earthy principle, supposing that this latter should be essentially the same in all metals? or ought they to be attributed to the difference of earths, which in that

case would be distinct and peculiar to each metal? or, lastly, do metals differ from each other, both by the nature of their earths, and by the proportion and intimacy of connection of their principles? All these things are entirely unknown; and we may easily perceive, that till they are known, we cannot discover what method to pursue in our attempts to accomplish the combinations we are now treating of.

The most essential point then is, to arrive at a knowledge of the true nature of the earths which are in metals; and the only method of arriving at this knowledge is, by reducing them to their greatest simplicity by a perfect calcination. But this cannot be accomplished but by long and difficult operations. We have seen above, that all metals are not calcinable with equal ease; that the perfect metals have not been hitherto calcined truly by any process; and that, in general, the last portions of phlogiston adhere very strongly to calcinable metals.

Some metals, however, as tin and regulus of antimony, may be easily calcined so as to be rendered irreducible. By carrying the calcination still further, we might obtain their earths so pure, that all their essential properties may be discovered, by which they might be easily compared together. This comparison would decide whether their nature be essentially different or not.

If they were found to be composed of earths essentially the same, we might next proceed to compare metallic with unmetallic earths. If the former were found similar to some of the latter kind, we should be then assured that the earth of metals is not peculiar to them, and that ordinary unmetallic earths are susceptible of metallification. From some late experiments, it was imagined that lime and magnesia alba were capable of being converted into metallic substances, but the processes are now found to be erroneous.

The greater the number of metals operated upon, the more general and certain the consequences resulting from these would be: so that, for instance, if the operation were extended to all calcinable metals; and if the result of each of these operations were, that the calxes, when perfectly dephlogisticated, do not differ from each other, and are similar to earths already known; we might conclude from analogy, and we should be almost certain, that the earths of the perfect metals are also of the same nature.

They who know the extent and difficulties of chemical operations, will easily perceive that this would be one of the most considerable. Nevertheless, after having determined this essential point, we should only have done half our work: For a knowledge of the nature of the earth of metals, and where it is to be found, would not be sufficient; we must further endeavour to find a method of combining with this earth a sufficient quantity of phlogiston, and in a manner sufficiently intimate, that a metal might be formed by such a combination. But this second difficulty is perhaps greater than the former.

We must observe here, that some famous chemical processes have been considered by many as metallifications, but which are really not so. Such is Becher's famous experiment of the *minera arenaria perpetua*, by which that chemist proposed to the States-General to extract gold from any kind of sand. Such also is the process of Becher and of Geoffroy, to obtain iron

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from all clays by treating them with linseed oil in close vessels. In these, and many other such processes, we only obtain metal that was already formed. Every earth and sand, as the intelligent and judicious Cramer observes, contains some particles of gold. Clays do not commonly contain iron ready formed; but all of them contain a ferruginous earth, naturally disposed to metallification. (See CLAY.) Accordingly we must conclude, that, by Mr Geoffroy's experiment, iron is only reduced or revived, but is not produced.

The great difficulties which occur in attempting to give a metallic quality to simple earths have induced a belief, that the nature of metals ready formed might be more easily changed, and the less perfect brought to a more perfect state. To effect this, which is one of the principal objects of alchemy, and is called *transmutation*, numberless trials have been made. As we have not any certain knowledge of what occasions the specific differences of metallic substances, we cannot decide whether transmutation be possible or not. In fact, if each metallic substance have its peculiar earth, essentially different from the earths of the others, and consequently if the differences of metals proceed from the differences of their earths; then, as we cannot change the essential properties of any simple substance, transmutation of metals must be impossible. But if the earths and other principles of metals be essentially the same, if they be combined in different proportions only, and more or less strictly united, and if this be the only cause of the specific difference of metals; we then see no impossibility in their transmutation.

Whatever be the cause of the differences of metals, their transmutation seems to be no less difficult than the production of a new metallic substance; and perhaps it is even more difficult. Alchemists believe that transmutation is possible, and they even affirm that they have effected it. They begin by supposing that all metals are composed of the same principles; and that the imperfect metals do not differ from gold and silver, but because their principles are not so well combined, or because they contain heterogeneous matters. We have then only these two faults to remedy, which, as they say, may be done by a proper coction, and by separating the pure from the impure. As we have but very vague and superficial notions concerning the causes of the differences of metals, we confess that we cannot make any reasonable conjecture upon this matter; and we shall only advise those who would proceed upon good principles, to determine previously, if metals have each a peculiar earth, or only one common to them all. In the second place, if it should be demonstrated that the earthy principle is the same in all metals, and if that be demonstrated as clearly as the identity of the inflammable principle in metals is proved; they must then determine whether these two be the only principles in metals, whether the mercurial principle exists, and whether it be essential to all metals or to some only, and what is the proportion of these two or three principles in the several metallic substances. When we shall clearly understand these principal objects, we may then be able to determine concerning the possibility of transmutation; and if the possibility should be affirmed, we shall then begin to discover the road which we ought to pursue.

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We have no reason to believe that any other principle enters into the composition of metals than those above-mentioned: no vestige is perceptible of either air or water. Some chemists have nevertheless advanced that they contain a saline principle. If that were true, they would also contain a watery principle. But all the experiments adduced to prove this opinion are either false, or only show the presence of some saline particles extraneous to the metals, or contained unknown to the chemists in the substances employed in the experiments. For metals perfectly pure, subjected to all trials with substances which do not contain and which cannot produce any thing saline, do not discover any saline property. We must however except arsenic, and even its regulus, these being singular substances, in which the saline are as sensible as the metallic properties.

Arsenic seems to be one of those intermediate substances which nature has placed in almost all its productions betwixt two different kinds, and which partake of the properties of each kind. Arsenic thus placed betwixt metallic and saline substances has properties common to both these kinds of substances, without being either entirely a metal or salt. See ARSENIC.

As water seems to act to a certain degree upon iron, even without the concurrence of air, as the operation of *martial ethiops* shows, we might thence suspect something saline in that metal. Nevertheless, what happens in that operation has not been so well explained, that any certain consequences can be deduced. 1. The water employed ought to be perfectly pure; that is, distilled rain-water. 2. The iron employed ought also to be perfectly pure, and such is very difficultly to be procured. 3. The operation ought to be performed in a bottle accurately closed, that we may be assured that the air contributes nothing to the action upon the iron. 4. After the water has remained a long time, suppose a year, upon the iron, it ought to be carefully filtrated and examined, to ascertain whether it really has dissolved any part of the metal.

In the mean time, we may conclude that metals do not seem to contain any saline principle. And when we consider well their general properties, they seem to be nothing else than earths combined more or less intimately with a large quantity of phlogiston. Although we can demonstrate that their inflammable principle is not in an oily state, and that it is pure phlogiston, they have nevertheless an oily appearance, in this circumstance, that they adhere no more than oils to earthy and aqueous substances, and that they always assume a globular figure when supported by these substances entirely free from phlogiston.

This resemblance is so sensible, that chemists, before they knew the nature of phlogiston, believed that metals contained an oily and fat matter. The cause of this quality of metals is the quantity of phlogiston which they contain. Sulphur, phosphorus, oils, and even fats, have this appearance merely from the inflammable principle which enters into their composition: for this property is communicated by that principle to every compound which contains a certain quantity of it. See PHLOGISTON.

When the phlogiston combines copiously and intimately with earthy matters so as to form metals, it

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probably so disposes them, that the primitive integrant parts of the new compound, that is, of the metal, approximate and touch each other much more than the integrant parts of simple earths can. This is proved by the great density or specific gravity, and other general properties, of metals.

In fact, as we cannot conceive that a body should be transparent, unless it have pores and interstices through which rays of light can pass; therefore the more dense a body is, that is, the fewer such interstices it has, the less transparent it will be; so that the densest bodies ought to be the most opaque as in metals. The disposition of the pores of bodies contributes also much to their greater or less transparency; and bodies, the pores of which are continued and straight, are more transparent than those whose pores are interrupted, transverse, or oblique; so that a body may be much more transparent than another which is less dense, as we see that glass is more transparent than charcoal. But when other circumstances are equal, the densest bodies are the most opaque. Therefore the opacity of bodies is proportionable to their density, and to the deviation of their pores from right and parallel lines.

From the great opacity of metals, they probably possess both these qualities in an eminent degree. We have seen, at the beginning of this article, that the lustre of metals, and their property of reflecting light much better than any other substance, are necessary consequences of their opacity. This is also self-evident, because the fewer rays any body can transmit, the more it must reflect.

Lastly, the ductility of metals proceeds also from their density, from the disposition of their pores, and from the action of latent heat; for even the most brittle bodies, such as glass, sealing-wax, &c. become ductile by heat. The softness, fusibility, and volatility, of which all metals partake more or less, and which many of them possess in a superior degree, being properties entirely contrary to those of the earthy principle, probably proceed from the inflammable principle.

The order in which metals compared with each other possess most eminently their principal properties, is the same as that in which they are here enumerated, beginning always with that metal in which the property is most considerable.

1. *Specific gravity or density.* Platina, gold, mercury, lead, silver, copper, iron, and tin.

2. *Opacity.* We cannot well compare metals with each other in this respect, because it is so considerable in all, that it seems complete. If, however, they differ in this respect, the same order will serve for opacity as for density.

3. *Metallic lustre or brilliancy.* The same observation which was made concerning the last mentioned property is applicable to this also. We must, however, observe, that as by polish bodies are rendered brighter, and that as whiteness contributes much to the reflexion of light, the whitest and hardest metals therefore reflect best. Hence, according to Mr Macquer, platina ought to be placed first; and then iron, or rather steel, silver, gold, copper, tin, lead.

Hardness of metals may contribute much to the duration of their polish; but certainly soft metals, if their

texture be equally compact, are no less capable of receiving a polish than hard metals. Some hard metallic allays have been found to be less liable to tarnish than softer compounds, and have for this reason also been chiefly used for speculums. The property of reflecting light seems chiefly to depend on the closeness of the particles or on the density, on the smoothness of the surface, and on the colour being most similar to the colour of the light to be reflected. The white metals, silver, mercury, tin, reflect light more abundantly than others. Gold, being the densest metal next to platina, and perhaps because the colour of solar light has a slightly yellowish tinge, does also reflect light very copiously. Hence speculums made of leaf-gold have been found to be very powerful. Iron or steel reflects much less light than any of the above-mentioned metals, although Mr Macquer has considered it as capable of a greater reflective power. Platina is generally in so small grains, that its reflective power cannot easily be determined. The precise degrees of that power which ought to be assigned to each of the above-mentioned metals, cannot without accurate experiments be ascertained. Perhaps, however, their reflective powers will be found to be more nearly in the following order, than in that above mentioned from Mr Macquer. Silver, quicksilver, tin, gold, copper, iron, lead.

4. *Ductility.* Gold, silver, copper, iron, tin, lead. The ductility of mercury and that of platina are not yet determined.

5. *Hardness.* Iron, platina, copper, silver, gold, tin, and lead.

6. *Tenacity.* By tenacity we understand the force with which the integrant parts of metals resist their separation. This force appears to be in a compound ratio of their ductility and hardness. The comparative tenacity of metals is measured by the weight which wires of the same diameter, made of the several metals, can sustain without breaking. Gold is the most tenacious; then iron, copper, silver, tin, lead. The tenacity of mercury is unknown: that of platina is not yet determined, but is probably considerable.

7. *Fusibility.* Mercury, tin, lead, silver, gold, copper, iron, and lastly platina, which cannot be fused by the greatest fire of our furnaces, but only by the solar focus, or by a fire excited by dephlogisticated air.

SECT. II. Of Mines and Ores in general.

THE substances found naturally combined with metals in the earth, are, particularly, sulphur and arsenic, sometimes separately, but generally conjointly. Metals combined with these substances are called *metals mineralised by sulphur*, or by *arsenic*, or by *sulphur and arsenic*; and these matters are called *mineralising substances*.

Besides the sulphur and arsenic with which metals are strictly combined in the mineral state, they are also pretty intimately combined with earthy substances, of different natures, and more or less divided.

These different matters united together form masses which are compact, heavy, brittle, and frequently possessed of much metallic lustre. These substances are properly called *ores*, or the matter of mines.

These ores are found in earths and stones of different kinds, as sands, flints, crystals, slates, indurated clays, according to the ground in which they are contained. But two kinds of stones in particular seem to accompany ores; and have therefore been considered by several mineralogists as matrixes in which metals are formed. One of these stones is a kind of crystal, generally white, milky, and semi-opaque, striking fire with steel, and of the class of vitrifiable earths. It is called QUARTZ.

The other stone is less hard, which does not strike fire with steel, and is sometimes milky like quartz; sometimes transparent and of different colours, consisting of rhomboidal crystals, which are composed of plates and faces. This stone becomes more soft and friable by being exposed to fire. It is called *spar*. Spar is more like to gypseous stones than to any other, but it differs from gypseous stones in possessing a much greater density. Some spars are so heavy, that they exceed in this respect all other stones. See SPAR.

These earthy and stony substances form the *matrix* of the ore.

Ores are natural compounds, containing metals alloyed with different substances.

Excepting gold, and a very small quantity of each of the other metals found in some places so pure as to possess all their characteristic properties, nature exhibits to us metals and semimetals differently alloyed not only with each other, but also with several heterogeneous substances, which so alter and disguise their qualities, that in this state they cannot serve for any of the purposes for which they are proper when they are sufficiently pure.

Ores consist, 1. Of metallic substances *calcined*; or, 2. Of these substances combined with other matters, with which they are said to be *mineralised*.

Calcined metallic substances, or *calciform ores*, are metallic substances deprived of phlogiston; and in the state of a calx or metallic earth. Such are all *ferruginous ochres*, which are calces of iron.

Mineralised ores, are, 1. *Simple*, containing only one metallic substance: or, 2. *Compound*, containing two or more metallic substances.

Of the simple, and also of the compound ores, four kinds may be distinguished.

1. Ores consisting of metallic substances mineralised by *sulphur*. Such is the lead-ore called *galena*, composed of lead and sulphur.

2. Ores consisting of metallic substances mineralised by *arsenic*. Such is the *white pyrites*, containing iron and arsenic.

3. Ores consisting of metallic substances mineralised by *sulphur* and by *arsenic*. Such is the *red silver-ore*, containing silver, arsenic, and sulphur.

4. Ores consisting of metallic substances mineralised by *saline matters*. Such are the *native vitriols*. Such also is probably the *corneous silver-ore*, which, according to Mr Cronstedt's opinion, is a luna cornea, or silver combined with marine acid. Of this kind of ores, or native metallic salts, is perhaps the *sedative salt of borax*, which from Mr Cadet's experiments, published in the Memoirs of the Royal Academy for the year 1766, is conjectured to be copper combined with marine acid, and which has been said to be found native. To this class also may be referred the *silver mineralised*

by an *alkaline substance*, which Mr Von Justi pretends to have discovered.

Henckel, and after him Cramer, and the author of the Dictionary of Chemistry, pretend, that in mineralised ores, besides the above mentioned metallic and mineralising substances, are also contained a metallic and an unmetallic earth. But Wallerius affirms, that the existence of such earths cannot be shown, and that sulphur is incapable of dissolving unmetallic earths, and even the calces of all metallic substances, excepting those of lead, bismuth, and nickel.

Metals and *metalliferous ores* are found in various places.

I. *Under water*; in beds of rivers, lakes, and seas, and chiefly at the flexures of these: such are the auriferous and ferruginous sands, grains of native gold, ochres, and fragments of ores washed from mines.

II. *Dissolved in water*: such are the vitriolic waters containing iron, copper, or zinc.

III. *Upon the surface of the earth*. Such are many ochres; metalliferous stones, sands, and clays; and lumps of ores. Mr Gmelin says, that in the northern parts of Asia ores are almost always found upon or near the surface of the ground.

IV. *Under the surface of the earth*. When the quantity of these collected in one place is considerable, it is called a *mine*.

Subterranean metals and ores are differently disposed in different places.

1. Some are *infix*ed in stones and earths, forming *nodules* or *spots* diversely coloured.

2. Some are equably and uniformly diffused through the substance of earths and stones, to which they give colour, density, and other properties. Such are the greatest part of those earths, stones, sands, clays, crystals, flints, gems, and fluors, which are coloured.

3. Some form *strata* in mountains. Such are the slates containing pyrites, copper-ore, lead-ore, silver-ore, or blend. These lie in the same direction as the strata of stones betwixt which they are placed; but they differ from the ordinary strata in this circumstance, that the thickness of different parts of the same metalliferous stratum is often very various; whereas the thickness of the stony strata is known to be generally very uniform.

4. *Fragments of ores* are frequently found accumulated in certain subterranean cavities, in fissures of mountains, or interposed betwixt the strata of the earth. These are loose, unconnected, frequently involved in clay, and not accreted to the contiguous rocks or strata immediately, nor by intervention of spar or of quartz, as the ores found in veins are. Tin and iron mines are frequently of the kind here described.

5. Large entire masses of ores are sometimes found in the stony strata of mountains. These are improperly called *cumulated veins*, because their length, relatively to their breadth and depth, is not considerable.

6. Some instances are mentioned of *entire mountains* consisting of ore. Such is the mountain Taberg in Smoland; and such are the mountains of Kerunavara and Luosavara in Lapland, the former of which is 1400 perches long and 100 perches broad. These mountains consist of iron-ore.

7. Lastly, and chiefly, metals and ores are found in oblong

Of Pyrites. oblong tracts, forming masses called *veins*, which lie in the stony strata composing mountains. See the article *MINE*.

SECT. III. Of the Pyrites.

PYRITE is a mineral resembling the true ores of metals, in the substances of which it is composed, in its colour or lustre, in its great weight, and, lastly, in the parts of the earth in which it is found, since it almost always accompanies ores. It is, like ores, composed of metallic substances, mineralized by sulphur or by arsenic, or by both these matters, and of an unmetallic earth intimately united with its other principles.

Notwithstanding the conformity of pyrites with ores properly so called, some chemists and metallurgists distinguish the former from the latter minerals; because the proportion and connection of the materials composing the pyrites differ much from those of ores. Thus, although sometimes pyrites contains more metal than some ores, yet generally it contains less metal, and a larger quantity of mineralizing substances, sulphur and arsenic, and particularly of unmetallic earth. The connection of these matters is also much stronger in pyrites than in ores, and they are accordingly much harder; so that almost every pyrites can strike sparks from steel.

From the above property of striking sparks from steel, they have been called *pyrites*; which is a Greek word signifying *fire-stone*. Pyrites was formerly used for fire-arms, as we now use flints; hence it was called *carabine-stone*. It is still named by some *marcasite*. Perhaps no other kind of natural body has received so many names. Persons curious to know the other names less used than those we have mentioned, may find them in *Henckel's Pyritologia*. We think, with that celebrated chemist, that the subject has been perplexed by this multiplicity of names; for before his great and excellent work, the notions concerning pyrites were very confused and inaccurate.

Pyrite differs also from ores by its forms and positions in the earth. Although pyritous metals generally precede, accompany, and follow veins of ores; they do not, properly speaking, themselves form the oblong and continued masses called *veins*, as ores do; but they form masses sometimes greater and sometimes smaller, but always distinct from each other. Large quantities of them are often found unaccompanied by ores. They are formed in clays, chalk, marles, marbles, plasters, alabasters, slates, spars, quartz, granites, crystals, in a word, in all earths and stones. Many of them are also found in pit-coals and other bituminous matters.

Pyrites is also distinguishable from ores by its lustre and figure; which is almost always regular and uniform, externally or internally, or both. Some ores indeed, like those of lead, many ores of silver, and some others, have regular forms, and are in some manner crystallized; but this regularity of form is not so universal and so conspicuous in ores as in pyrites. The lustre of pyrites seems to be caused by its hardness, and the regularity of its form by the quantity of mineralizing substances which it contains.

By all these marks we may easily, and without analysis, distinguish pyrites from true ores. When we see a mineral that is heavy, possessed of metallic lustre, and

of any regular form, the mass of which appears evidently to be entire, that is, not to have been a fragment of another mass, and which is so hard as to be capable of striking sparks from steel, we may be assured that such a mineral is a pyrites, and not an ore.

The class of pyrites is very numerous, various, and extensive. They differ one from another in the nature and proportions of their component parts, in their forms, and in their colours. The forms of these minerals are exceedingly various. No solid, regular or irregular, can easily be conceived, that is not perfectly imitated by some kind of pyrites. They are spherical, oval, cylindrical, pyramidal, prismatical, cubic; they are solids with 5, 6, 7, 8, 9, 10, &c. sides. The surface of some is angular, and consists of many bases of small pyramids; while their substance is composed of these pyramids, the points of which all unite in the centre of the mass.

Pyritous minerals differ also in their component substances. Some of them are called *sulphureous*, *martial*, *cupreous*, *arsenical*, as one or other of these substances predominate. We must observe with Henckel, whose authority is very great in this subject, that in general all pyrites are martial; as ferruginous earth is the essential and fundamental part of every pyrites. This earth is united with an unmetallic earth, with sulphur or arsenic, or with both these matters; in which case, the sulphur always predominates over the arsenic, as Henckel observes. He considers these as the only essential principles of pyrites; and believes that all the other matters, metallic or unmetallic, which are found in it, are only accidental; amongst which he even includes copper, although so much of it exists in some kinds of pyrites, that these are treated as ores of copper, and sometimes contain even 50lb. of copper each quintal. Many other metals, even gold and silver, are sometimes combined in pyrites; but these are less frequent, and the precious metals always in very small quantities; they are therefore justly to be considered as accidental to pyrites. The different substances composing pyrites sensibly affect its colours. Henckel distinguishes them in general into three colours, white, yellowish, or a pale yellow, and yellow. He informs us, that these three colours are often so blended one with another, that they cannot be easily distinguished unless when compared together.

The white pyrites contain most arsenic, and are similar to cobalt and other minerals abounding in arsenic. The Germans call them *mispickel*, or *mispilt*. Iron and arsenic form the greatest part of this pyrites. As arsenic has the property of whitening copper; some pyritous minerals almost white, like that of Chemnitz in Misnia, are found to contain 40 pounds of copper per quintal, and which are so much whitened by the arsenic, that they are very like white pyrites. But Henckel observes, that these pyritous matters are very rare, and are never so white as the true white pyrites, which is only ferruginous and arsenical.

Yellowish pyrites is chiefly composed of sulphur and iron. Very little copper and arsenic are mixed with any pyrites of this colour, and most of them contain none of these two metallic substances. This is the most common kind of pyrites: it is to be found almost everywhere. Its forms are chiefly round, spherical, oval, flattened, cylindrical; and it is composed internally of needles.

Of Pyrites. needles or radii, which unite in the centre, or in the axis of the solid.

Yellow pyrites receives its colour from the copper and sulphur which enter into its composition. Its colour, however, is inclined to a green; but is sufficiently yellow to distinguish it from the other two kinds of pyrites, particularly when they are compared together. To make this comparison well, the pyrites must be broken, and the internal surfaces must be placed near each other. The reason of this precaution is, that the colour of minerals is altered by exposure to the air.

Persons accustomed to these minerals can easily distinguish them. The chief difficulty is, to distinguish white pyrites from cobalt and other minerals; which also contain some copper and much arsenic.

Hence then we see, that arsenic is the cause of whiteness in pyrites, and is contained in every pyrites of that colour; that copper is the principal cause of the yellow colour of pyrites; and that every pyrites which is evidently yellow contains copper; that sulphur and iron produce a pale-yellow colour, which is also produced by copper and arsenic; hence some difficulty may arise in distinguishing pyrites by its colours. We may also observe, that sulphur and arsenic, without any other substance, form a yellow compound, as we see from the example of orpiment or yellow arsenic. Thus, although the colours of the pyrites enable us to distinguish its different kinds, and to know their nature at first sight, particularly when we have been accustomed to observe them; yet we cannot be entirely certain concerning the true nature of these minerals, and even of all minerals in general; that is, to know precisely the kinds and proportions of their component substances, but by chemical analysis and decomposition.

Besides the above-mentioned matters which compose pyrites, it also contains a considerable quantity of unmetallic earth; that is, an earth which cannot by any process be reduced to metal. Henckel, Cramer, and all those who have examined this matter, mention this earth, and prove its existence.

We ought to observe, that this earth is combined with the other principles of the pyrites, and not merely interposed betwixt its parts. It must therefore be distinguished from other earthy and stony matters mixed accidentally with pyrites, and which do not make a part of the pyrites, since they may be separated by mechanical means, and without decomposing that mineral: but the earth of which we now treat is intimately united with the other constituent parts of the pyrites, is even a constituent part of pyrites, and essential to the existence of this mineral, and cannot be separated but by a total decomposition of it.

According to Henckel, this unmetallic earth abounds much in the white pyrites, since he found from the analyses which he made, that the iron, which is the only metal existing in these pyrites, is only about $\frac{1}{16}$ th part of the fixed substance that remains after the arsenic has been expelled by torrefaction or sublimation.

A much larger quantity of iron is in the pale-yellow pyrites, according to Henckel. The proportion of iron is generally about 12 pounds to a quintal of pyrites, and sometimes 50 or 60 pounds: this is therefore called *martial pyrites*. It contains about

one-fourth of its weight of sulphur, and the rest is Of Pyrites. unmetallic earth.

The quantity of unmetallic earth contained in the yellow or cupreous pyrites, which are also martial, since, as we have observed, iron is an essential part of every pyrites, has not yet been determined. They probably contain some of that earth, though perhaps less of it than the others.

The nature of this unmetallic earth of pyrites has not been well examined. Henckel thinks that it is an earth disposed already by nature to metallification, but not sufficiently elaborated to be considered as a metallic earth. This opinion is not improbable; but as alum may be obtained from many pyrites, may we not suspect that this unmetallic earth is of the nature of the basis of alum or argillaceous earth? Perhaps also this earth is different in different kinds of pyrites. The subject deserves to be well examined.

Although pyrites are not so valuable as true ores, because in general it contains less metal, and but exceedingly little of the precious metals; and because its metallic contents are so difficult to be extracted, that, excepting cupreous pyrites, which is called *pyritous copper ore*, it is not worked for the sake of the contained metal; yet it is applied to other purposes, and furnishes us with many useful substances; for from it we obtain all our green and blue vitriols, much sulphur, arsenic, and orpiment. *See the principal processes by which these substances are extracted from pyrites, under the section SMELTING of ORES.*

As all pyrites contain iron, and most of them contain also sulphur; as the pyrites most frequently found contains only these two substances with the unmetallic earth; and as iron and sulphur have a singular action upon each other when they are well mixed together and moistened; hence many kinds of pyrites, particularly those which contain only the principles now mentioned, sustain a singular alteration, and even a total decomposition, when exposed during a certain time to the combined action of air and water. The moisture gradually penetrates them, divides and attenuates their parts; the acid of the sulphur particularly attacks the martial earth, and also the unmetallic earth; its inflammable principle is separated from it, and is dissipated. While these alterations happen, the pyrites changes its nature. The acid of the sulphur which is decomposed, forms with the fixed principles of the pyrites, vitriolic, aluminous, and selenitic salts; so that a pyrites, which was once a shining, compact, very hard mineral, becomes in a certain time a greyish, saline, powdery mass, the taste of which is saline, austere, and styptic.

Lastly, if this mass be lixiviated with water, crystals of vitriol, and sometimes of alum, according to the nature of the pyrites employed, may be obtained by evaporation and crystallization.

This alteration and spontaneous decomposition of pyrites, is called *efflorescence* and *vitriolization*; because the pyrites become covered with a saline powder, and because vitriol is always formed. This vitriolization is more or less quickly accomplished in pyrites according to its nature. It is a kind of fermentation excited by moisture amongst the constituent parts of these minerals; and it is so violent in those which are most disposed

Of Pyrites. posed to it, that is, in the pale yellow pyrites, which contain chiefly sulphur and iron, that when the quantity of these is considerable, not only a sulphureous vapour and heat may be perceived, but also the whole kindles and burns intensely. The same phenomena are observable, and the same results are formed, by mixing well together, and moistening a large quantity of filings of iron and powdered sulphur; which experiment Lemeris has made, to explain the causes of subterranean fires and volcanoes.

We cannot doubt that, as the earth contains very large masses of pyrites of this kind, they must undergo the same changes when air and moisture penetrate the cavities containing them; and the best natural philosophers agree, that very probably this surprising decomposition of pyrites is the cause of subterranean fires, of volcanoes, and of mineral waters, vitriolic, aluminous, sulphureous, hot and cold.

No other pyrites is subject to this spontaneous decomposition when exposed to humid air, but that which is both martial and sulphureous; that is, the pale-yellow pyrites. The arsenical pyrites, or that which contains little or no sulphur, is not changed by exposure to air. This latter kind is harder, heavier, and more compact, than the former. The pyrites which is angular and regularly shaped, is chiefly of this kind. Mr Wallerius, in his Mineralogy, proposes to distinguish this kind of pyrites by the name of *marcasite*. When cut, it may be polished so well as to give a lustre almost equal to that of diamonds, but without refracting or decomposing the light; for it is perfectly opaque. It has been employed some years past in the manufacture of toys, as of buckles, necklaces, &c. and is called in commerce *marcasite*.

We cannot, however, concur with Mr Macquer (from whom the above is taken), in thinking that there is sufficient reason for considering the minerals called *pyrites*, as a distinct class of substances from ores. They have indeed no mark by which they can certainly and constantly be distinguished from these. The hardness or property of striking ignited sparks from steel is not common to all the substances generally called *pyrites*; for we find some of these enumerated by mineralogists which have not that property. Wallerius even mentions a pyrites which contains no iron, altho' that metal is thought by Henckel to be essential to pyrites. The distinction of pyrites from ores has been chiefly introduced by miners, because the greatest part of the former minerals contain so little metal, and so much of the mineralising substances, sulphur, or arsenic, that they are seldom smelted. Nevertheless, some kinds of pyrites are found which contain so much copper, that they are smelted with great profit. Accordingly, some later mineralogists consider the cupreous yellow pyrites as an ore of copper, the pale-yellow martial pyrites as an ore of iron; and the white arsenical pyrites as an ore of arsenic. See *Ores of Copper*, *Iron*, and of *Arsenic*, below.

SECT. IV. *Assaying of Ores in general.*

ESSAYS are chemical operations made in small, to determine the quantity of metal or other matter which is contained in minerals; or to discover the value or

purity of any mass of gold or silver. The former kind is the subject of the present section; the latter is treated under the word *ESSAYS*, in the order of the alphabet.

Before essays of ores can be well made, a preliminary knowledge of the nature of the several metallic minerals ought to be attained. Each metal has its proper and improper ores, which have peculiar characters and appearances: hence persons accustomed to see them, know pretty nearly by the appearance, weight, and other obvious qualities, what metal is contained in a mineral. A good assayer ought to be very intelligent in this matter, that he may at once know what the proper operations are which are requisite to the essay of any given mineral.

As metals are very unequally distributed in their ores, we should be apt to make false and deceitful essays, if we did not use all possible precautions that the proportionable quantity of metal produced by an essay shall be nearly the medium contained in the whole ore. This is effected by taking pieces of the mineral from the several veins of the mine if there be several, or from different places of the same vein. All these minerals are to be shaken together with their matrixes. The whole is to be well mixed together, and a convenient quantity of this mixture is to be taken for the essay. This is called the *lotting* of the ore.

As essays, particularly the first, are generally made in small, assayers have very small weights corresponding to the weights used in the great; that is, to the quintal or hundred pounds weight, to pounds, ounces, drams, &c. The essay quintal and its subdivisions vary according to the difference of weights in different countries; and this occasions some confusion when these weights are to be adjusted to each other. Tables of these weights are found in treatises of assaying; and particularly in that written by Schlutter, and translated and rendered more complete by Hellot, which contains all the details necessary for the subject.

The custom is to take, for the essay quintal, a real weight of a gros, or dram, which in France is equal to 72 grains; but as the whole dram represents 100 pounds, each grain represents a pound and a fraction of a pound; and hence some difficulty and confusion arise in making the subdivisions. A better method is that of Mr Hellot, which is to make the fictitious or essay quintal equal to 100 real grains, and then each grain represents a real pound. This essay quintal is sufficiently exact for ores of lead, tin, copper, iron, antimony, bismuth, and mercury. But for ores of silver and gold, another representation is convenient: for these metals, as Mr Hellot says, are generally in so small quantity, that the button or small piece of metal obtained in the essay could not be accurately weighed if 100 real grains were made to represent a quintal; and the difficulty of separating the gold from so small a quantity would be still greater. These motives have induced Mr Hellot to use for these ores a fictitious quintal 16 times bigger; that is, equal to 1600 real grains, which represent 1600 ounces; that is, 100 lb. or quintal. The ounce being represented by a grain, its several subdivisions must be represented by fractions

Assaying of
Ores.

Assaying of
Ores.

† The
pounds, of
which 100
are here
supposed to
make a
quintal, are
called *Paris*
pounds, one
of which
contains
1269 Troy
grains.

of a grain. Thus 12 grains of the fictitious quintal correspond with $\frac{1}{8}$ of a real grain (n); and this latter quantity may be accurately weighed in assay-balances: which when well made are sensible to a much less weight. See (*Essay*)-BALANCE.

When a quintal of an ore to be assayed has been weighed, and lotted, as we described above, it is to be roasted in a test under a muffle. It is to be washed, if necessary; and, in short, the same operations are to be made in small which are usually done in great. Additions also are to be made, and in proper proportions, according to the peculiar nature of the ore. The fluxes generally mixed with the assays in ore are three, four, or five parts of black flux; one, two, or three parts of calcined borax; and one half of that quantity of decrepitated common salt. The more refractory the ore is, the more necessary is the addition of these fluxes: then the whole mixture is to be fused either in a forge or in a melting or assay furnace.

To make assays well, all possible attention and accuracy are to be employed. This object cannot be too much attended to; for the least inaccuracy in weighing, or loss of the smallest quantity of matter, might cause errors, so much greater as the disproportion betwixt the weights employed and those represented is greater. The most minute accuracy therefore is necessary in these operations. For instance, the assay-balances ought to be small, and exceedingly just. The ore ought not to be weighed till it has been reduced to gross powder fit for roasting; because some of it is always lost in this pulverization. When the ore is roasted, it ought to be covered with an inverted test; because most ores are apt to crackle and disperse when first heated. To make the fusion good and complete, the precise degree of fire which is requisite ought to be employed; and when it is finished, the crucible ought to be struck two or three times with some instrument, to facilitate the disengagement of the parts of the regulus from the scoria, and to occasion their descent and union into one button of metal. The crucible ought not to be broken, nor its contents examined, till it is perfectly cold.

Upon breaking the crucible, we may know that the fusion has been good, if the scoria be neat, compact, and equal; if it has not overflowed or penetrated the crucible; if it contain no metallic grains; and if its surface be smooth, and hollowed in the middle. The regulus or button ought to be well collected, without holes or bubbles, and to have a neat convex surface; it is then to be separated from the scoria, well scraped and cleaned; and, lastly, is to be weighed. If the ope-

ration has been well made, its weight shows the quantity of metal which every real quintal of ore will yield in the great. If the perfect success of this assay be in any respect doubtful, it ought to be repeated; but the best method at all times is, to make several assays of the same ore. Some small differences are always found, however well the assays may have been made. By taking the medium of the results of the several operations, we may approach as nearly as possible the true product of the ore.

Lastly, as mines are not worked, nor founderies established (which cannot be done without considerable expence), till the ore has been assayed, 10 or 12 real pounds of the ore ought to be previously assayed; and assayers ought to be furnished with necessary furnaces and instruments for these larger assays.

In Part II. to the several articles of the ores of metals, we shall add the most approved methods of assaying these ores. We shall here only further observe in general, that the methods commonly practised for assaying ores of imperfect metals, and semimetals especially, are insufficient to procure the whole quantity of metal contained in ores, or even so much as is obtained in the smelting of large quantities of ores; and that therefore the result of assays is not to be considered as the precise quantity contained in an ore, but generally only as an inaccurate approximation to that quantity. M. Gellert ascribes one cause of the want of success of these operations to the alkaline salts employed as fluxes to the ores, by which most metallic calces are partially soluble, but more especially so when any of the sulphur of the ore remains; which, by uniting with these salts, forms a hepar of sulphur which is the most powerful of all solvents. He proposes therefore to omit the black flux, and other alkaline salts, and to add nothing to the ore but powder of charcoal and some fusible glass. This method, he says, he learned from Mr Cramer, and has himself used with much success in the assays of iron and copper: but finding that other imperfect metallic substances could not sustain the heat necessary to effect the fusion and vitrification of the unmetallic parts of the ore without being partly dissipated, he found it necessary to add in the assays of these latter metallic matters some borax, by which the fusion might be completed with less heat. As we consider this as a considerable improvement in the art of assaying ores, we shall, to the articles of the several ores, add not only the processes commonly prescribed, but all those of Mr Gellert, according to the method here mentioned.

Assaying of
Ores.

P A R T II.

Containing a summary Description of the principal ORES of each METAL, and the Methods of Assaying them.

SECT. I. Ores of Gold.

§ 1. **P**ROPERLY speaking, no ores of gold exist: for as this metal cannot be alloyed with arsenic, nor with sulphur, it is never found directly mixed.

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neralised by these substances, as the other metals are. In the second place, if it be mineralised indirectly by the union it contracts with other metals naturally combined with sulphur and arsenic, so small a quantity of it only is found in these ores, that they

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they scarcely even deserve the name of *improber ores of gold*.

Hence gold is found either in its natural state, of a certain degree of purity, possessed of all its properties; or engaged with some other metals in certain minerals.

The gold which is found alone is called *native* or *virgin gold*. This is generally incruited, and fixed in different kinds of stones, principally in flints and quartz. Mr Cramer says, that the yellow brilliant spots of the blue stone called *lapis lazuli*, are native gold; but these are very small.

Gold is also found in fat and muddy earths; and Mr Cramer affirms, that scarcely any sand can be found which does not contain gold; but he acknowledges, at the same time, that the quantity is too small to compensate for the expence of obtaining it.

Lastly, the largest quantity of native gold is to be found in the sands of some rivers. It is chiefly collected in hollows at the bottom of these rivers, and at their several bendings. The gold is collected in these places by a natural operation, similar to that of washing of ores.

A considerable quantity of gold is in the sands of several rivers in France: so that persons who collect it find enough to compensate their trouble. Mr Reaumur, in a memoir that he gave in the year 1718 concerning the rivers of France which contain gold, enumerates ten of them; namely, the Rhine, the Rhone, the Doux, the Ceze, and the Gardon; the Arriege; the Garonne; two streams which flow into the Arriege, called *Ferriet* and *Benagues*; lastly, the Salat, the source of which is in the Pyrenean mountains.

The Ceze is the river which furnishes the largest quantity of gold at certain times. Mr Reaumur observes, that its particles are larger than those of the Rhine and of the Rhone; and says, that in some days a peasant will find gold to the value of a pistole, and in others will scarcely find any.

The native gold found in rivers or elsewhere is never perfectly pure, or of 24 karats. It always contains a certain quantity of allay, which is generally silver. The gold of the French rivers, according to Mr Reaumur's trials, was found to be from 18 to 22 karats, that of the Ceze being the lowest, and that of the Arriege being the purest.

Although gold, however, as above observed from Macquer, cannot be directly dissolved by sulphur, yet it probably may be mineralised by the intervention of other metallic matters. Thus, although no proper ore of gold exists, yet it is found in several mineral substances, in which it is always accompanied, as Cramer affirms, with a much larger quantity of silver; to which latter metal that author attributes its mineralised state. The minerals containing gold are blend, cupreous and arsenical pyrites, ore of antimony, cinabar, white ore of arsenic, vitreous and other silver ores, and the lead-ore called *galena*.

Gold is more frequently imbedded in quartz than in any other matrix, but it is also found in limestone and in hornblend. Gold mines are in general very precarious, as they do not form regular veins, nor is the gold uniformly distributed through a matrix.

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Becher and Cramer think, that no sand is entirely free from gold. The yellow, red, black, and violet-coloured ferruginous sands, are said to contain most gold. Mr Hellot relates, that in 11 essays of one kind of sand, from a quintal, or 921,600 grains, were obtained each time from 848 to 844 grains of noble metal, exclusive of the gold which remained in the scoria; and that of the metal thus obtained two thirds were gold, and the remaining third was silver. He says, that parcels of sand taken up at very small distances from each other contained very unequal proportions of gold.

The gold found in sands is generally less pure than that which is imbedded in a solid matrix. Reaumur says, that a piece of gold, weighing 448 ounces, was shown to the Royal Academy at Paris, which was found upon essay to have different fineness in different parts of the mass.

§ 2. *Ores and earths containing gold may be assayed* by the methods directed for the extraction of gold from large quantities of these auriferous matters, (see Part III.): or they may in general be assayed by being fused in a cupel or test, placed under the muffle of an assay-furnace, or in a crucible placed in an air furnace, with eight or ten times their quantity of lead if they be easily fusible, and with a larger quantity of lead if they be difficultly fusible; and by scorifying the earthy matters, while the lead becomes impregnated with the noble metals. These operations are entirely similar to those employed for the separation of silver from its ores by precipitation with lead; a detail of which see subjoined under the section ORES of SILVER, [Processes I. III. IV. V. VI.]. These metals are afterwards to be separated from the lead by cupellation, in the manner directed in the article ESSAY (of the value of silver and of gold). The gold is then to be separated from the silver by the processes described in the article PARTING.

The quantity of lead to be added to the ore in this essay must be such as renders the scoria very thin, that the whole gold may be imbibed by the lead. Some iron ores containing gold cannot be reduced into a scoria sufficiently thin with 16 times their quantity of lead, unless the heat be at the same time considerably increased. When the ore is exceedingly refractory, the scorification ought to be promoted by adding to it four times its quantity of tartar, twice its quantity of nitre, and four times its quantity of litharge. This mixture is to be put into a good assay-crucible, and covered with the sea-salt. The crucible is to be set in a forge-hearth, and exposed gradually to heat, till the scoria has acquired sufficient fluidity, and the lead has imbibed the noble metal.

See the methods which have been used for assaying auriferous sands, under Part III.

SECT. II. Ores of Platina.

PLATINA is very rare, and has been but lately discovered. As, like gold, it cannot be allayed with sulphur or with arsenic, probably no ore, properly so called, exists of this metal. Accordingly in the only mines of platina which we know, namely, the gold mines of Santafe near Carthagena, the platina is found native like the gold, and in its metallic state.

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Ores of
Gold.

SECT. III. *Ores of Silver.*

§ 1. NEXT to gold, silver is the metal most frequently found in its metallic state, that is, not mineralised by sulphur or by arsenic. This silver, called also *native* or *virgin*, generally affects some regular form, and consists of filaments or vegetations of various figures. It is found in form of plates, of fibres, or of grains, or crystallized. It lies generally in quartz, flint, spar, slate, cobalt, and in silver-ores. It is sometimes enveloped in a thin stony crust. It is generally allayed with some gold: but silver, like all the other metals, is much more frequently found mineralised by sulphur and by arsenic.

Three principal proper ores of silver are known, which are very rich, but very rare. These are:

1. The *vitreous silver ore*. This ore has no determinate figure, and has nearly the colour, softness, and fusibility of lead. It is very heavy, and contains three quarters of its weight of pure silver. In this ore the silver is mineralised by sulphur alone. Some expert artists imitate it very well by combining sulphur with silver by fusion in a crucible.

This ore, according to Cronstedt, is either in form of plates or of fibres, or is crystallized, or has no determinate figure. It may be imitated by adding about five parts of sulphur to one part of melted silver; in which operation most of the sulphur is consumed; or it may be imitated by exposing a plate of silver red-hot to the fumes of burning sulphur.

2. The *horny* or *corneous silver ore*. This ore is so called from its colour and semitransparency, by which it resembles horn or colophony. When suddenly heated, it crackles, as almost all ores do, and melts with a gentle heat. Two-thirds of it are silver, which is mineralised by sulphur and arsenic. This ore is very rare. Wallerius says, after Woodward, that it is found at Johaun-Georgen-Stadt in Saxony.

Corneous ore has various colours; white, pearly, brown, yellow, greenish, or reddish. It is foliated and semitransparent. It is somewhat ductile, and fusible with the flame of a candle. When heated, it emits, as Wallerius says, a sulphureous and blue flame, and, according to Cramer, also a very small quantity of an arsenical fume. Wallerius says, that it contains two-thirds of silver, with a considerable quantity of sulphur, and a small quantity of arsenic. Lehman thinks that it is silver united with a little arsenic. But Mr Cronstedt says, that it is a luna cornea, or silver combined with marine acid; and that it is incapable of being decomposed but by substances which can unite with that acid. This latter opinion seems to be the most probable; as the ore, according to its description, is similar to luna cornea, and as it cannot be imitated by any mixture of sulphur and of arsenic with silver. The blue flame, and the smell slightly arsenical, which are emitted from heated corneous ore, are also observable from every combination of marine acid with a substance containing phlogiston.

3. *Red silver ore*, called also *rosiclar*. Its colour is more or less red; it is sometimes crystallized, very heavy, and is fusible like the above-mentioned ores. In this ore the silver is mineralised by arsenic and by

sulphur, but chiefly by the former. It also contains a little iron, and furnishes two-thirds of its weight of silver. Its red colour may proceed either from the iron it contains; or from the mixture of arsenic and sulphur; or, lastly, from the particular manner in which the arsenic is united with the silver, an example of which we have in the red precipitate of silver made by the neutral arsenical salt.

Red silver ore is either plated or solid, or crystallized, and frequently semitransparent. Its colour is various, from a dark grey to a deep red, according to the proportions of the two mineralising substances. It crackles and breaks in the fire, exhales an arsenical fume, and is readily fused. It is found generally in quartz, spar, crystal, hornblend.

Besides the three silver ores above described, the following ores contain silver mixed with other metals.

1. *Grey silver ore*. This contains copper and silver mineralised by arsenic and sulphur, and generally more of the former than of the latter metal; but as it is valued chiefly for the silver, it has been generally enumerated amongst silver ores.

2. *White silver ore* is an arsenical pyrites containing silver.

3. *Black silver ore* contains sulphur, arsenic, copper, iron, sometimes lead, and about a fourth part of silver, according to Wallerius.

4. *Plumose silver ore* is white or black, striated like plumb-alum, or like ore of antimony. It is silver mineralised by sulphur, arsenic, and antimony.

5. *Pech-blend*. In this blend silver, gold, and zinc, are mineralised by sulphur, probably by intervention of iron, by which the gold and zinc are rendered capable of uniting with the sulphur.

6. Silver is frequently found in *galena*; and sometimes in *martial pyrites*; in the *red ore of arsenic*; in various *ores of copper*, *lead*, *tin*, *iron*, and especially *cobalt*; in *blends*; in *yellow* or *red earths*; in *black* and *blue basaltes*; and also in *strata of stones* which do not appear externally to contain any mineral substance.

7. *Liquid silver ore* or *guhr of silver*, is a grey or whitish liquid mass, which contains, as Wallerius says, either native silver, or some fluid substance capable of producing it. Mr Cronstedt mentions, in the Swedish Memoirs, a water flowing through a mine in Norway containing silver. Another instance is also mentioned of a silver guhr, in the *Ad. Erud. Upsal.* 1720.

8. Mr Von Justi pretends, that he has found silver mineralised by an *alkaline substance*; but he has not spoken sufficiently distinctly concerning it, to know whether he means a saline or earthy alkaline matter. Henckel also pretends, that by treating calcareous earth or certain clays with pyrites, silver may be obtained.

§ 2. *Ores of silver may be assayed by the same methods which are employed for the extraction of that metal from large quantities of ores; which methods are different, and suited to the different qualities of the different ores. See Part III. Or, in general, ores and earths containing silver may be assayed by the following processes, which are copied from Dr Mortimer's*
English

Effaying of English edition of Cramer's Art of Effaying Metals, Ores of Silver. Part II. Process 1.

Effaying of Ores of Silver.

P R O C E S S I.

To precipitate Silver by means of Lead from fusible Ores.

" POUND the ore in a very clean iron mortar into fine powder: of this weigh one docimaistical centner or quintal, and eight of the like centners of granulated lead.

" Then have at hand the docimaistical test, which must not as yet have served to any operation: pour into it about half of the granulated lead, and spread it with your finger through the cavity of it.

" Put upon this lead the pounded ore; and then cover it quite with the remainder of the granulated lead.

" Put the test thus loaded under the muffle of an essay-furnace, and in the hinder part of it: then make your fire, and encrease it gradually. If you look thro' the holes of either of the sliders, you will soon see that the pounded ore will be raised out of the melted lead, and swim upon it. A little after, it will grow clammy, melt, and be thrown towards the border of the test: then the surface of the lead will appear in the middle of the test like a bright disc, and you will see it smoke and boil: so soon as you see this, it will be proper to diminish the fire a small matter for a quarter of an hour; so that the boiling of the lead may almost cease. Then again, increase the fire to such a degree, that all may turn into a thin fluid, and the lead may be seen, as before, smoking and boiling with great violence. The surface of it will then diminish by degrees, and be covered over with a mass of scorias. Finally, have at hand an iron hook ready heated, wherewith the whole mass must be stirred, especially towards the border; that in case any small parcels of the ore not yet dissolved should be adherent there, they may be brought down, taking great care not to stir any the least thing out of the test.

" Now, if what is adherent to the hook during the stirring, when you raise it above the test, melts quickly again, and the extremity of the hook grown cold is covered with a thin, smooth, shining crust; it is a sign that the scorification is perfect; and it will be the more so as the said crust adherent to the hook shall be coloured equally on every side: but in case, while the scorias are stirred, you perceive any considerable clamminess in them, and when they adhere in good quantity to the hook, though red-hot, and are inequally tinged, and seem dusty or rough with grains interspersed here and there; it is a sign that the ore is not entirely turned into scorias. In this case, you must with a hammer strike off what is adherent to the hook, pulverize it, and with a laddle put it again into the test, without any loss or mixture of any foreign body, and continue the fire in the same degree till the scoria has acquired its perfection and the above-mentioned qualities. This once obtained, take the test with a pair of tongs out of the fire, and pour the lead, together with the scoria swimming upon it, into a cone made hot and rubbed with tallow. Thus will the first operation of the process be performed, which does

not commonly indeed last above three quarters of an hour.

" With a hammer strike the scorias off from the regulus grown cold, and again examine whether they have the characteristics of a perfect scorification; if they have, you may thence conclude, that the silver has been precipitated out of the ore turned to scorias, and received by the lead.

" When the scorification lasts longer than we mentioned, the lead at last turns to scorias or litharge, and the silver remains at the bottom of the vessel: but the fire must be moderately supplied, and the vessels be extremely good, to produce this effect; for they seldom resist to the strength of the scorias long enough; so that the whole scorification may be brought to an end; which has afterwards this inconveniency, that the silver is dissipated by grains in the small hollows of the corroded ore, and can hardly be well collected again, when the ore has but little silver in it. Nay, there is still more time to be consumed to obtain the perfect destruction of the lead, by means of the combined actions of the fire and air, because the scorias swimming at the top retard it considerably.

" In this process, the sulphur and the arsenic of the silver-ore, when the ore is broken small, and extended widely in a small quantity, are in part easily dissipated by the fire, and in part absorbed by the lead; the lighter part of which, swimming upon the heavier, becomes very clammy by means of the sulphur which is in the ore; but when this is dissipated by the violence of fire, it turns into glass or scorias: but when arsenic is predominant in the ore, the plumbeous part turns immediately into a very penetrating and very fusible glass, having a dissolving efficacy, unless the arsenic lies hidden in a white pyrites or cobalt. For this reason, the fixed part of the ore, which is no silver, is dissolved by that glass, melts, and assumes the form of scorias. The unmetallic earths and the pure copper or lead ores thereto adherent are of this kind. The silver then remains immutable; and being freed of these heterogeneous bodies, which are partly dissipated and partly melted, it is precipitated and received by the remaining regulus of lead. Therefore this process is completed by three distinct operations; viz. 1. By roasting. 2. By scorification. 3. By the melting precipitation of the silver, which is the result of the two former operations.

" The ore must be pulverised very fine, in order to increase the surface, that the dissipation of the volatiles and the dissolution by litharge may be sooner effected. This pulverising must then be done before the ore is weighed, because there is always some part of the ore adherent to the mortar or iron plate on which it is made fine; which part being lost, the operation is not exact. Erker was in the right when he prescribed eight centners of lead for the subduing of fusible ores. Nevertheless, it must be owned, that this quantity is superfluous in some cases. However, as the fluxibility of the silver-ore depends upon the absence of stones, pyrites, &c. it is easy to see, that there are an infinite number of degrees of fluxibility which it would be needless to determine exactly, and most commonly very difficult to determine by the bare sight. Besides, a little more lead does not render the process imperfect; on the contrary, if you use too

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small a quantity of lead, the scorification is never completely made. Nay, there are a great many ores, containing sulphur and arsenic in plenty, that destroy a considerable quantity of lead: such are the red silver-ore, and that wherein there is a great deal of the steel-grained lead-ore. If the fire must be sometimes diminished in the middle of the process, it is in order to hinder the too much attenuated litharge, which is continually generated out of the lead, from penetrating the pores of the test, and from corroding it; which is easily done when the fire is over-strong; for then the surface of the vessel which is contiguous to the lead contracts cavities, or, being totally consumed by small holes, lets the regulus flow out of it. The vessels that are most subject to this inconvenience are those in the materials of which lime, plaster, and chalk are mixed. Nay, these bodies, which are in their nature refractory, being eroded during their scorification, at the same time communicate a great clamminess to the scoria; so that a great quantity of the mass remains adherent to the test, in the form of protuberances, when you pour it out; whereby a great many grains of the regulus are detained."

PROCESS II.

THE regulus obtained by the process I. contains all the silver of the ore, and the unscorified part of the lead. The silver may be afterwards separated from the lead, and obtained pure by *cupellation*; which process is described under the article ESSAY (*of the value of Silver.*)

PROCESS III.

If the silver-ore cannot be washed clean, or if it be rendered refractory by a mixture of unmetallic earths and stones, the scorification of these earthy matters frequently cannot be completed by the process I. Cramer therefore directs, that such ores shall be treated in the following manner.

"Bruise the ore into an impalpable powder, by grinding in a mortar; to a docimastical centner of it add a like quantity of glass of lead finely pulverised; for the more exactly these two are mixed together, the more easily the scorification afterwards succeeds. Put this mixture, together with 12 centners of lead, into the test, according to process I. then put the test under the muffle.

"Make first under it a strong fire, till the lead boils very well; when you see it so, diminish the violence of the heat, as was directed in the first process; but keep it thus diminished a little longer: then, finally, again increase the fire to such a degree, till you perceive the signs of a perfect scorification and fusion. *See the whole process I.* Now this process lasts a little longer than the foregoing, and requires a greater fire towards the end.

"It sometimes happens that a very refractory ore cannot be dissolved by litharge; and that a mass, which has the clamminess of pitch, swims upon the regulus and upon the scorias themselves which are already subdued in part: when you see this, shut the vents of the furnace to diminish the fire; then gently touch this refractory body with a small iron cold hook, to which it will immediately stick; take it off softly, not to lose any thing; pound it into a fine powder,

adding a little glass of lead, and put it again into the test; then continue the scorification till it is brought to its perfection. But you must always examine the scoria of your refractory ore, to see whether there may not be some grains of regulus dispersed in it: for sometimes the scorias that grow clammy retain something of the metal; which if you suspect, pound the scorias into a fine dust, and thus the grains of metal will appear if there are any left, because they can never be pounded fine. The silver is separated from this regulus by cupelling, as in Process II.

"All earths and stones are refractory in the fire: for although some of them melt naturally in the fire, as those that are vitrifiable do; nevertheless all the others, a very few excepted, melt much more difficultly than metals, and never become so thin in the fusion as is required for the sufficient precipitation of a precious metal. But litharge itself does not conveniently dissolve these refractory matters by the help of fire alone, unless you add some mechanical mixture to them; for the very moment the said litharge penetrates through the interstices of the refractory ore, and begins to dissolve it, a tenacious mass is produced, which hardly admits any farther dilution by the litharge. You may see it plain, if you make coloured glasses with metallic calces: if you pour carelessly upon them a calx that gives a colour, you will never obtain that they may be equally dyed on every side, even although you should torture them for whole days together in a great fire. Nay, glass already made can never be diluted by only pouring salts and litharge upon it. Wherefore, you must use the artifice of glass-makers, who, in the making of the most perfect glasses, take great care, before they put the species of their ingredients into the fire, to have a mechanical mixture precede, or at least accede, during the fusion itself, which is done here by pounding glass of lead mixed with the ore: but if you think that your glass of lead is not sufficiently fusible, you may add to it litharge melted first, and then pounded into a fine powder.

"As this scorification requires a longer and a greater fire than the foregoing, and as a greater quantity of litharge is moreover requisite to subdue the refractory scoria; it is easy to see why a much greater quantity of lead must be used here than in Process I.; and, although less lead is often sufficient, it is nevertheless proper always to use the greatest quantity that can be necessary; lest, for instance, it should be necessary to try so many times the lead alone, to make it evident how much silver the lead when alone leaves in the coppel. Nor need you fear lest any thing of the silver be taken away by the lead, provided the coppels be good, and the cupelling duly put in execution: for you can hardly collect a ponderable quantity of silver out of the collected fume of the lead, which rises during the cupelling, as well as out of the litharge that is withdrawn into the coppel."

PROCESS IV.

If the ore be rendered refractory by pyrites, Cramer directs that the silver should be precipitated by lead in the following manner. (*Art of Assaying, Part II. proc. 4.*)

"Break

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“ Break your ore into a rough powder, and put a centner of it into the test : put upon this another test in the manner of a tile ; put it under the muffle hardly red-hot : increase the fire by degrees. There will always be a crackling : which being ended, take away the upper-test ; for when the vessels have been red-hot about one minute, the ore ceases to split. Leave the ore under the muffle till the arsenic and the sulphur are for the most part evaporated ; which you will know from the cessation of the visible smoke, of the smell of garlic, or the acid ; then take away the test, and leave it in a place not too cold, that it may cool of itself.

“ Pour out, without any dissipation, the roasted ore, and with a knife take away what is adherent to the vessel ; pound it to a most subtile powder, and grind it together with an equal weight of glass of lead ; and, finally, scorify the whole collected ore in the same test wherein the testing was made, unless it has contracted chinks, as was described in Process III.

“ *Remarks.* “ Yellow pyrites-ores contain a very great quantity of sulphur, even greater than is necessary to saturate the metal that lies hidden in them.— For which reason this superfluous sulphur dissipates in a middling fire ; but if it had been mixed with lead, it would have rendered it refractory, nor could it afterwards be dissipated from it without a considerable destruction of the lead. The white arsenical pyrites turn also a great quantity of lead into glass, on account of the abundance of the arsenic they contain. For which reason these ores must be previously roasted, that the sulphur and arsenic may be dissipated. Nor need you fear lest any part of the silver be carried away with the arsenic ; for when arsenic is separated from any fixed body, by a certain degree of fire, it carries nothing of that body away with it.”

PROCESS V.

Silver may be precipitated from its ore by cupellation only, in the following Process, given by Cramer. [Art of Assaying, Part II. Proc. 9.]

“ Pound one centner of ore ; roast it in the manner directed in the last process ; beat it to a most subtile powder ; and if it melts with difficulty on the fire, grind it together with one centner of litharge, which is not necessary when the ore melts easily : then divide the mixture or the powder of the ore alone into five or six parts, and wrap up every one of them severally in such bits of paper as can contain no more than this small portion.

“ Put a very large coppel under the muffle ; roast it well first, and then put into it sixteen centners of lead : when the lead begins to smoke and boil, put upon it one of the said portions with the small paper it was wrapt up in, and diminish the fire immediately, in the same manner as if you would make a scorification in a test, but in a lesser time. The small paper, which turns presently to ashes, goes off itself, and does not sensibly increase the mass of the scorias. The ore proceeding therefrom is cast on the border, and turns to scorias very soon. Increase the fire again immediately, and, at the same time, put another portion of the ore into the coppel, as was just now said. The same effects will be produced. Go on in the

same manner, till all the portions are thrown in and consumed in the lead. Finally, destroy the remaining lead with a stronger fire.

“ The silver that was in the ore and in the lead will remain in the coppel. If you deduct from it the bead proceeding from the lead, you will have the weight of the silver contained in the ore. If the ore employed was easy to be melted, all the scoria vanishes ; but if it was refractory or not fusible, all the scoria does not always go away, but there remains something of it now and then in the form of dust. A great many ores and metals may be tried in this way, except only such as split and corrode the coppels.— There are likewise some of them which must be previously prepared in the same manner as is required to render them fit for going through a scorification.— See the foregoing Processes.

“ *Remarks.* The ore thrown at several times upon lead boiling in a coppel may be dissolved without the foregoing scorification ; but this is very far from having an equal success with all kinds of ores ; for there are ores and metals which resist very much their dissolution by litharge ; and which being on this account thrown on the border, are not sufficiently dissolved ; because the litharge steals away soon into the coppel. Nevertheless, there are some others which vanish entirely by this method, except the silver and gold that was contained in them.

“ A previous roasting is necessary, first, for the reasons mentioned, and then because the ore thrown upon boiling lead should not crackle and leap out ; for, having once passed the fire, it bears the most sudden heat.”

PROCESS VI.

Silver may be precipitated out of the same bodies as were mentioned in the foregoing processes by scorification in a crucible. [Cramer, Proc. 15.]

“ The body out of which you intend to precipitate silver must be previously prepared for a scorification by pounding and roasting, as mentioned in the former processes. Then, in the same manner, and with the same quantity of lead, put it into a crucible strictly examined, that it be entire, solid, not speckled with black spots, like the scoria of iron, especially at its inferior parts, and capable of containing three times as much. Add besides glass gall and common salt, both very dry, and enough, that when the whole is melted, the salts may swim at top at the height of about half an inch.

“ Put the crucible thus loaded into a wind-furnace ; shut it close with a tile ; put coals round it, but not higher than the upper border of the crucible. Then light them with burning coals, and increase the fire till the whole melts very thin, which will be done by a middling fire, maintained always equal, and never greater ; leave it thus for about one quarter of an hour, that the scorification may be perfectly made. Take off the tile and stir the mass with an iron wire, and a little after pour it out into the mould. When the regulus is cleaned from scorias, try it in a test by cupelling it.

“ *Remarks.* The scorification of any ore whatever, or of any body fetched out of ores, may indeed be

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be made by this apparatus, as well as in a test under a muffle: but it serves chiefly to the end that a greater quantity of metal may be melted from it with profit. For you may put many common pounds of it at one single time into the crucible; but then you need not observe the proportion of lead prescribed in the foregoing process; nay, a quantity of lead two or three times less is sufficient, according to the different qualities of the object. But the mass will certainly be spilt, unless you choose a very good crucible; for there is no vessel charged with litharge that can bear a strong fire having a draught of wind, without giving way through it to the litharge.

"You add glass-gall and common salt, that they may forward the scorification, by swimming at top; for the refractory scoria rejected by the litharge, and adhering between this and the salts that swim at top, is soon brought to a flux, and the precipitation of the silver is thereby accelerated. They also hinder in a manner a small burning coal fallen into the crucible, from setting the litharge a boiling, which troubles the operation; for the litharge or glass of lead, especially that which is made without any addition, so soon as the phlogiston gets into it, rises into a foamy mass, consisting of a multitude of small bubbles very difficult to be confined, unless the phlogiston be entirely consumed, and the litharge reduced to lead, which sometimes rises above the border of the vessel."

The *corneous ore*, if it really be, as Cronstedt says, a luna cornea, ought to be treated in some of the methods directed for the reduction of luna cornea. See *CHEMISTRY-Index*.

PROCESS VII.

Silver and gold may be extracted from their ores by mercury.

A new method of extracting the precious metals by means of amalgamation with mercury has lately been introduced into Germany. The attraction between these has indeed been known from the most remote antiquity: Vitruvius informs us, that by this means gold might be recovered from embroidery and old cloaths; and Pliny mentions the gilding of brass and other metals by the same means. From time immemorial mercury has been made use of in the streaming for gold, in order to purify and collect together the gold dust which is dispersed in the sands; and almost all nations who practise this use the same process. The gold sand, after being washed, is triturated with quicksilver, and the superfluous metal separated by straining through leather. By the miners it was used in a similar manner; the stones containing gold being first pounded and then triturated in mills along with the mercury. But it was soon found, that in these mills there was a large quantity left behind in the residuum, so that it was necessary to subject what was left to the action of fire; on which account the mills were deemed unnecessary, and are now almost every where disused. The process of extracting gold and silver by amalgamation, however, was looked upon to be essentially deficient, by reason of an opinion which prevailed among the chemists, that mercury could not dissolve either of these metals except in their pure and perfect state; whence it was supposed, that a great quantity

which fire could have extracted was left by the mercury. This opinion was supported by the most celebrated metallurgists, as Schlutter, Gellert, Wallerius, and Kramer; whence it became generally believed, that amalgamation would never answer in great operations. But of late Baron Inigo Born has not only demonstrated that this can be done to great advantage, but has actually introduced it, notwithstanding that some difficulties were thrown in his way. The following is an account of the methods which have been practised for separating gold and silver from their ores by means of quicksilver.

This process was introduced into some of the mines of Mexico in 1566 by Don Pedro Fernandez de Velasco, and in 1571 into some of those of Peru by the same person; and from thence it quickly spread thro' all the mines in the south and north-east parts of America, inasmuch that it is almost the only method used in that part of the world for extracting these metals. The richer ores, however, are purified by fusion with lead; and our author informs us, that formerly the poorer kinds of ores were certainly thrown away, and when the method of amalgamation was introduced into Peru, the old barrows were searched for the ores which had been rejected as useless, but were now put to the quicksilver.

In the year 1588, Don Juan de Corduba, a Spaniard, applied to the court of Vienna, proposing to extract silver from its ores, whether poor or rich, by mercury, and in a short space of time. He made some experiments upon different kinds of ore, which on a small scale succeeded very well, but on attempting it with 20 quintals of it he failed; and as Lazarus Erker, who was employed to give in a report concerning it, disapproved of the method, it was not pursued any farther. The reasons alleged in Baron Born's book for this failure are, that he did not calcine his ore; that he did not use any salt; and that the weather was too cold; though this last circumstance might have been remedied had Corduba attended to it.

Another Latin and anonymous account of the mode of amalgamation is preserved among the records of the aulic chamber. It is directed to the emperor, but the year in which it was written is not mentioned. According to the account given by the author of this paper, he had examined the mines of Guatemala in New Spain, and made some useful regulations for them. He directs the ore to be calcined in furnaces like limekilns, the fire being kept up according to the nature of the ores, after which they are to be reduced to powder in mills or stamps. The pulverised matter is then passed through fine iron sieves, and put into earthen or copper vessels by 10 or 20 quintals at a time; more or less salt being mixed with it according to circumstances. The light-coloured ore requires 50 lb. to every thousand, and the darker somewhat more. To this mixture are to be added five pounds of dry tartar, two pounds of pulverized horn, and three pounds of brick-dust. Some kinds of ores require but a small quantity of these additions.

After the mixtures are put into the boilers, as much water is added as will make the whole of the consistence of paste moderately thick; the vessels must be exposed to sunshine, or kept in a place warmed artificially, adding more water when the matter begins to dry; and it must

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Baron
Born's New
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must be stirred up three or four times a-day. At the expiration of three or four days, various colours appear upon the surface. After this 15 lb. of brimstone is to be added to every thousand pounds of ore, and the whole worked over again; but this addition is by the baron considered as quite superfluous. Lastly, 100 lb. or less of quicksilver is added, according to the nature of the ore; the whole mass is carefully worked over, and left at rest for 10 hours. A fire must next be kindled under the boiler, and the matter it contains triturated or stirred for two days together; keeping it always sufficiently diluted by a proportionable quantity of water. It is, lastly, allowed to rest for 12 hours, and then dried.

When this operation is successfully performed, if the ores be rich, particles of amalgam will be seen in it: these are collected, washed out, and kept for further use, the leavings being carried to a place fit for washing over. This place ought to be on the slope of an hill, where a kind of pit is dug out and lined with brick and mortar, and ought to be large enough to contain 25 quintals. A stream of water is then made to run upon it, and the matter stirred without intermission. The superfluous water runs over the rim of the pit, and carries off the lighter stony and earthy particles, the heavy amalgam remaining at bottom. This is then to be mixed with the small clots already mentioned, which were taken out of the mass originally, and pressed through a cloth made of hemp or coarse linen. The quicksilver, which comes through clean, is kept for farther use; the remainder distilled off in proper vessels, and the remaining silver melted into ingots. By this method it is said that even very poor ores are worked to advantage, the expence being very moderate.

The following method of extracting gold from its ores is very much recommended by our author: "The auriferous sand, which contains gold grains and gold-dust, is concentrated by washing; and without any calcination goes to the above mentioned washing-pit, which for this purpose need not be so large. On its upper part is fixed a square launder, about 12 feet long, covered in the bottom with a woollen cloth, in order to retain any part of the gold-dust which may be carried over with the water and stuff gently stirred in the pit. When the water carries off no more mud, but runs clear, the farther supply is to be stopped; the water in the pit is pumped or taken out with buckets; the coarser sand in the bottom is separated or scraped off by hands; and the finer heaviest sand at the bottom is mixed with quicksilver. Then it is squeezed through a piece of cloth; the quicksilver comes off without any gold, which separated from the sand remains as an amalgam, and is pure after the remaining quicksilver has been evaporated. The sand and heavier dust remaining on the launder is washed and treated in the same manner.

"The auriferous ores and loadstones, however, which rise from different mines, are calcined like silver ores, more or less as the nature of their matrixes will direct. Then they are ground and sifted; and the auriferous stuff, thus prepared, is put into heaps, exposed to the sunshine, and worked and turned about for three or four days. It requires no salt. Afterwards

sulphur, and at last quicksilver, are added and mixed with it. There is no occasion for fire under the vessel in which it is triturated, except in winter; and two days after, though not dried, it is immediately carried to the washing-pit, and treated like the amalgam of silver.

"This method of extracting gold and silver is so certain and safe, that when other methods of amalgamation extract only one ounce of gold and silver, this produces three or four from the poorest ores in a shorter time and with less expence."

P. Joseph Acosta tells us, that at Potosi 6000 or 7000 quintals of quicksilver are annually consumed in the dressing of the ore, not to mention what is recovered from the leavings of the first washing. These leavings, called *lamas*, are burnt in particular furnaces in order to extract the remaining quicksilver; and there are upwards of 50 such furnaces near Potosi and Tarapaja. The ore refined there amounts, according to the best information, to the immense quantity of 300,000 quintals. Only about 2000 quintals of the quicksilver are recovered, which shows a loss of about two pounds of quicksilver on every quintal of ore. The ores are of different natures, and in proportion to the silver they contain require more or less quicksilver. That which contains most, requires naturally the greatest quantity of quicksilver; though some of the workmen pretend that there is a kind which contains very little silver, and yet requires a great deal of mercury: but whether this be owing to the ignorance of the workmen, or to the mercury being absorbed by some other matter, is not generally known. The ore is first pulverised in mills, and then passed through iron or brass sieves. The mills will grind, when properly regulated, 30 quintals in the space of 24 hours. The pulverised matter is put into heaps in the open air, and salt is mixed with it in the proportion of 5 to 50 quintals of the ore, in order to macerate and cleanse it of its impurities, that the quicksilver may the more readily amalgamate with the metal. Upon these heaps, and while they are stirring, the quicksilver is pressed through a cloth. Before the invention of fire-places, the ore was repeatedly kneaded with quicksilver in wooden troughs, and formed into large round masses, which were left in that form for two days; after which they were worked again, until the metals appeared to be embodied together, which took from 9 to 20 days; but it was afterwards found that heat assisted the operation so far, that by means of proper ovens the same might be accomplished in five or six days. When the quicksilver has taken up the silver, and wholly separated it from its matrix the lead and the copper, the ovens are opened, the matter is taken out, and the quicksilver expelled and recovered in the following manner. The mixture is put into water troughs, and stirred therein by means of mills and water-wheels, by which the earthy and extraneous particles are washed away, and the amalgam settles at the bottom. The sediment looks like sand. It is further washed over in flat plates, and perfectly cleansed; what goes off with the water is collected for further use under the name of *relaves*. When the amalgam is become clean and bright by this method, it is put into a cloth and squeezed out. The uncombined quicksilver

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silver runs off, and the remaining body of amalgam contains five parts of quicksilver and one of solid metal. It is made into masses named *pinnas*, having the form of a sugar loaf, hollow within, and weighing about 100 pounds. They are exposed to a strong fire in order to expel the quicksilver, after being put into pots covered with earthen heads. The silver still appears in the form of amalgam, but is reduced to one sixth of the former weight. Its texture is spongy, and the quality of the metal so fine, that the silversmiths cannot work it, neither can it be formed into coin, without an alloy. Baron Born observes, however, that it is only cold amalgamation which produces silver of such uncommon fineness; by hot amalgamation it is generally alloyed with copper, which cannot be parted from it without cupellation.

The most circumstantial account of the amalgamation of silver ore is that of Alonzo Barba. He divides the ores into two classes: 1. those which are best treated by fire and fusion; and, 2. such as are most fit for amalgamation. Those called *pacos* and *tacana*, may be amalgamated; but that none of their richer contents may be lost, it will be best to combine them with lead, and proceed by cupellation. The former of these ores has no lustre or brightness. It is said to be of a reddish-yellow, soft and friable; seldom rich in silver, and mostly valuable on account of its being easily got from the mine. Tacana is a rich silver ore, of a black colour, sometimes of a grey or of an ash-colour; or a brown, rich, silvery earth. 3. The *plomo* is too rich for pulverisation and amalgamation, and is therefore simply melted down with the tacana. This seems to be the same with the horn-silver ore; and is described as almost entirely consisting of native silver, of a black, grey, or greenish-white colour. Barba says that they found at Potosi some *plomo* of a cinnabar colour, which they had not seen any where else; but Baron Born thinks that here he has mistaken the red silver ore for another species. Frezier asserts, that in what he calls the *plomo ranco*, the native silver appears upon rubbing or scratching it, and that it gives white and very pure silver by simple fusion without any amalgamation. In the imperial cabinet at Vienna, there is a specimen weighing about a pound, of black horn silver ore from Potosi, on the polished surface of which the virgin silver appears very plainly. 4. The *machacado* (virgin silver or gold grown in the matrix in the form of wire or hair), is amalgated in the mortar. 5. The *soroches* (lead ores containing silver), are melted along with the *rosicler* and *conchiso*, two kinds of red silver ore. 6. The *negrillos* (grey copper and white silver ores) may be refined by amalgamation, though they are more fit for fire.

Besides this classification into such as are fit for fire, and those for amalgamation, the ores require further to be sorted into such as require the addition of particular substances for their amalgamation. Vitriol is generally hurtful, especially when salt is added to the vitriolic ores; and it requires the addition of iron, tin, lead, and lime, in order to counteract its effects; but in some cases it is of service, and promotes amalgamation. The calcination of vitriolic ores is of no service, but rather the contrary, as it disengages the vitriol, and brings on a vitriolic efflorescence. It may, however, be separated by washing till the water comes

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off tasteless and sweet. The amalgamation is disturbed by sulphur, bitumen, and antimony, only by the smoothness and needle-like figure of the particles, which reduce the quicksilver to a kind of dust. The ores mixed with these always run into reguli, and must therefore be put into a strong calcining fire; if melted without calcination, they would run entirely into dross and scoria.

The finer the ores are pounded so much the better; and after putting the powder thro' a fine sieve, the coarser part goes again to the mill: they ought to be previously burnt, in order to assist the operation of grinding. The best method of obtaining fine powder is by washing over; but as this is very apt to pack and turn clammy, it ought to be mixed with sand.

The ores are known to be sufficiently calcined by their change of colour and loss of brightness. Barba tells us, that all bright ores must be calcined, but with great care, that no vitriol may be disengaged, as that proves injurious to the amalgamation; but Baron Born says, that one of the greatest objects in the calcination of the Hungarian ores is to decompose the sulphur into vitriol, as promoting the decomposition of the salt. The amalgamation is likewise promoted by burning and calcination, in as far as it promotes the pulverization of the ore, and assists the action of the quicksilver; but it is chiefly useful in the black and grey silver ores. It can only be determined by circumstances whether it be better to pulverize the ores before or after calcination. Their value is best known by pounding them previous to calcination. The stuff must be constantly stirred during the time it is calcining, and some powder taken from the mass to be tried with quicksilver and salt. The thickening of the quicksilver, and the grain of the stuff, show what additions are necessary, or whether the calcination be completed or not. When ores are calcined in lumps, the fire does not act equally upon all their parts; though this method is attended with the advantage of losing much less dust, as well as saving the expence of stamps and mills.

Ores cannot be calcined in reverberatory furnaces, as the heat would run it together, and part of the metals themselves would be carried off by the strong current of air and the violent smoke. Barba recommends a furnace of an oblong square figure, with three vaults over each other; the fire is put into the lowermost, and the ore into the two upper ones. The heat circulates by means of lateral openings in the walls, and is let out on the back without a flue. The heat is graduated by registers and dampers on the outside.—Whatever kind of furnace, however, is used, some of the ore will have clotted, and must therefore be ground to a fine powder; but to prevent as much as possible these inconveniences, the hard ores ought to be calcined before they go to the mill, and the soft ones after, but with proper additions. The iron ores, which resist the fire longer, are calcined with an addition of sulphur, or of sulphureous and antimonial matter, proportioned to the iron they contain; but sulphureous and antimonial ores require to be calcined with the scoria of iron. Arsenical ores, or those mixed with orpiment and sandarac, are calcined with lead glance; and those mixed with white or black bitumen, must be calcined with iron scoria or pounded limestone.

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The impurities of ores, and the additions proper to be made to them, are determined by pounding them coarsely, and throwing them upon a heated plate of iron. If the smoke be white or black, it shows a mixture of bitumen of these colours; if yellow, it shows orpiment; if red, sandarac; if greenish-yellow, sulphur.

Salt ought not to be used in the calcination of ores, as it would calcine the silver; and the duration of the calcining must be determined by the change of colour which the ores undergo by calcination by themselves, and the brightness they assume by trituration with quicksilver. It is also a mark of sufficient calcination when antimonial and sulphureous ores no longer send out a disagreeable smoke; if the thick and black smoke of bituminous ores become white; and if the silver in the stuff appears in white glittering sparks. Vitriolic ores may also be calcined in the same manner; but they require a longer time with the addition of alum and salt: they, however, require no farther addition in the subsequent operations; and in the course of four days all their silver will be taken up by the quicksilver. Less quicksilver will also be lost; for as there is no occasion for the frequent turning and working of the heap, a very small part of it only can be turned into useless dust. Vitriolic ores ought always to be well washed with water before they are calcined; and if there is still a suspicion of their being vitriolic, they must be tried by quicksilver: if it takes a lead-colour, the stuff must be washed till iron put into it no longer takes a copper colour. The lixivium is kept as an useful addition to some ores.

Amalgamation, according to Alonso Barba's method, is performed in three ways, viz. in heaps or caxons, in the boiler, and in mortars.

1. *In heaps.* Before the operation takes place in the large way, an essay is made of three or four pounds of the fine sifted powder taken from the general quantity; and according to the produce of this he calculates that of the whole. He tries it also with quicksilver, to know perfectly the method he is to follow, and the additions that are to be made. In this essay the following method is adopted: 1. The matter is elixated, to extract the vitriol if there be any. 2. One pound of the lixiviated matter is tried with quicksilver and salt, carefully observing the colour and its change. If the quicksilver assumes the appearance of silver filings, and these quicksilver flakes become thinner and thinner, it proves that the amalgamation goes on successfully, and that there is no occasion for any addition. The whole is stirred from time to time, till the quicksilver seems to diminish, and recover its natural form, but without dividing into small globules; after which the matter is to be washed, as all the silver is by that time completely taken up. The ores of *Verenguela de Pacages* are treated only with quicksilver and salt, and yet yield their full produce.

When the ore turns black, iron is added; when of a light lead-colour, tin; if a dark lead-colour, lead; and if of a yellowish or gold-colour, lime. The three first of these are styled by Baron Born, "very idle and useless additions."—The ore frequently divides into small and powdery globules, in consequence of the hardness of the minerals, or from too much stir-

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ring; but this may be prevented by calcination before it is reduced to powder, or by less stirring. In a great many operations, however, this quicksilver dust can scarcely be avoided. It serves the workmen as an index of the progress they have made, or sometimes as a direction how to operate; and has different names according to the cause by which it is produced; as quicksilver dust, the dust of addition, and silver dust. The first of these arises simply from too great division, and is white without any quickness, scarcely moving when the matter is stirred with water: it sticks somewhat to the bottom, and runs into globules when broken between the fingers. The second is produced by the amalgam of lead and tin; and, when pressed between the fingers, unites with the quicksilver which had begun to combine with the silver. The third comes from the amalgam of silver: it sinks towards the coarser stuff on the bottom, and floats about in flakes of different sizes; turning into an amalgam when rubbed or pressed between the fingers. All of these are produced chiefly when there are lead, marcasite, and iron ores in the mixture; or by vitriol of copper, which is particularly productive of this minute division of the quicksilver. They are produced also by too plentiful an addition of salt, which thickens the water, and prevents the descent of the particles of quicksilver.

According to the produce of the essay the large heap is regulated. It is first wetted with water, and mixed with the due proportion of salt; but at the beginning only one third of the quicksilver and one half of the lead and tin are added. It is turned over once every day during the two first days, because the quicksilver being then uncombined would be apt to be driven off in small globules, and a great waste occasioned. The heap is likewise too much cooled by the addition of too much quicksilver at once; so that it is better to put it gradually to the other matters. The lead and tin are always thrown into the heap along with the quicksilver; but too much of either is hurtful, by deadening the quicksilver, and preventing the amalgamation. All these additions, however, must vary according to circumstances; observing that the quantities added must always be less and less in proportion as the amalgam advances to perfection. The matter should be kept rather dry than otherwise, and two parts of amalgam be in the heap to one of fluid quicksilver. Too great an abundance of this fluid mass is very detrimental, on account of the quantity of quicksilver dust which it occasions; and if the other ingredients are accidentally wasted, the *dust of addition* will be changed into *quicksilver dust*; which having very little weight, will be poured off along with the water. But when lime is added, the whole must be mixed at once, and the entire heap turned over two or three days, till the quicksilver be added. Too much lime prevents the union of the two metals, and is an inconvenience which cannot be remedied.

The heaps are frequently turned and worked over after the first two days, which is attended with several advantages; as that the quicksilver is thus heated, more thoroughly mixed with the matter, and the silver is purified by the frequent rubbing. The heaps, however, are subject to various accidents, owing to

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the difference between the various kinds of ores, which cannot always be exactly known. When the quicksilver is deadened by too large an addition of lead, iron, tin, or lime, it loses its oval form, and assumes a vermicular one: if shaken in a glass, or other vessel, without water, it adheres to the sides in threads, and is unfit for taking up the silver. The best remedy is vitriol of copper, or the lixivium of vitriolic ores already mentioned; or powder of copper may be thrown into the heap. All additions of this kind, however, must be made very cautiously, and in consequence of experiments made by small essays, which determine the quantity of materials to be used. When the heaps have too much vitriol, without any correcting ingredient, the quicksilver has a leaden colour, and the smaller particles assume a spherical form. Iron might be added to absorb the too great quantity of vitriolic acid; but there is no certain rule for the proportion to be added, so that it must be determined by experiment.

When the quicksilver appears, on turning the heaps, like a bunch of grapes, this shows an excess of salt, which prevents the quicksilver from combining with the silver: it is to be remedied by the addition of some coarse stuff which cleanses the fluid. Some add ashes; but the best and most natural remedy is alum, which is found at Potosi in abundance, and whitens the silver. If the heap be not turned equally, or the quicksilver added at a proper time, or if the silver do not unite with it, some of the silver will appear in a dry form, and lie on the coarser stuff like a cobweb; and if not skimmed off in time, will be carried away by the washing water. To collect this dry silver, and the finest quicksilver dust, some silver amalgama is pressed upon it through a chamois skin; and the whole is once more turned and worked over. The frequent turning, the heat of the climate and season, as well as the fermentation produced in the heap by the vitriol and other additions, all promote the amalgamation; but cold, neglect of stirring, and the quicksilver assuming a lead-colour, are against it. It is, however, very difficult to determine the maturity of the heap, when all the silver is taken up, and the matter may go to the washing; though great inconveniences attend an ignorance in this respect. If washed too soon, some silver is left in the leavings; and if worked too long, there is a loss of quicksilver as well as time and labour. The difficulties attending the knowledge of this important point, are by our author enumerated as follow: "The heap may appear not to require any additional quicksilver; the silver dust may appear to be completely collected; that of quicksilver may begin to make its appearance; the amalgama may begin to appear pure, and to show a gold-colour; and yet silver may remain in the leavings. The most infallible test of the maturity of the heap, is the essay of the triturated stuff by fire. If no silver is produced thereby, then so much quicksilver is thrown into the heap, that it may contain three parts of amalgama to two of silver, or at least one part of quicksilver to two of amalgama. By this additional fresh quicksilver, all the dust of quicksilver, and the dry and uncombined quicksilver, are perfectly collected; the amalgama is the heavier for it, and sinks the more readily to the bottom when brought to the washing-tub.—

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Some clean quicksilver is also put into the bottom of this tub; the inside of which must be lined with iron plate well cleaned, and rubbed with quicksilver; (though this last operation seems to be quite superfluous, as mercury will not in the least unite with iron by rubbing.) "The stuff brought into the tub must be diluted with a great quantity of water, and be stirred round with a pestle lined with iron-plate in such a manner that it may turn round six times one way and six times the other, always touching the bottom; the unconnected bodies of quicksilver and amalgama are thereby to meet, to combine, and to fall to the bottom. To recover the salt which had been mixed with the heap, the water must be evaporated:" but the Baron observes, that at Shemnitz no salt is recoverable from the lixivium; and if any be recovered by the Spaniards, it only shows that they add too much, and that part of the remainder is undecomposed by the vitriolic acid. The quicksilver is separated from the amalgama much in the same way as already described.

2. *Amalgamation by boiling*, was accidentally discovered by Barba, in an attempt to fix quicksilver.— On mixing silver ore finely powdered with quicksilver, and boiling it with water in a copper vessel, he found that the metals readily united; and thus having discovered a shorter method of amalgamation, he gradually improved and introduced it into practice in Peru. In this operation the boilers must be of copper, earthen or other vessels being found not to answer: the copper also must be pure, because the quicksilver would dissolve the metals with which it is alloyed. They must be in the shape of inverted cones, and flat-bottomed. The under part has a rim of six or eight inches high and half an inch broad, all beat of one piece. Other copper plates are fixed in the inside with copper nails; and care must be taken that it be water-tight, that no quicksilver may run off; and for the better security, the inside of the boiler may be lined with lime and ox-blood. The boilers may be of any magnitude; their upper parts being surrounded with iron rings with strong handles, into which a cross board is wedged. In the middle of this board is a hole for the spindle to move in. The spindle is of light wood, and moves on a brass pivot in the bottom. It has four wooden wings, with three or four perpendicular bars, also of wood; the farthest from the spindle being the shortest; the highest so long as to sweep the bottom. It is turned by a moveable handle on the upper end.

These boilers are put into an oblong furnace, capable of holding 10 of them; the fire-place being in the middle, and the flame and smoke passing under the boilers, and going out on both ends of the furnace by two chimnies. The fire being lighted, first the water, then the fine stuff, and at last the quicksilver, is put in; observing always that the bottom be fully covered with quicksilver. The water must always be kept boiling, otherwise the operation may be interrupted or become tedious: on account of the evaporation, the boilers must be supplied with a quantity of water, in small quantities at a time, that the boiling be not checked. The stuff must be proportioned to the size of the boiler: if too little be put in, the amalgamation goes on too slowly; while too much would

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not allow the mass to be thick enough, or to boil with sufficient freedom. Some of the amalgam is to be taken out from time to time with a long laddle, and the progress of the operation is judged of by the colour. The essay of the stuff determines whether all the silver be taken out of it in this manner. Some quicksilver is then thrown upon the surface of a sample of the boiled stuff, and worked round with it in a vessel two or three times. If the quicksilver rises and takes up some of the stuff, some silver remains; if not, the whole is taken up. Then the fire is stopped, the spindle is taken out, and the water and stuff let off. The coarser matter on the quicksilver may at all events be washed in cold water, and go once more to the mill. Almost the whole of the silver amalgama lies upon the surface of the quicksilver, immediately under the stuff, sometimes four or five fingers thick; the fire under the boilers preventing the silver from uniting with the quicksilver in the bottom. This metal, when poured off, must be pressed and treated in the usual manner.

The advantages attending this method are, that the heat promotes the union of the metals, while the boiling of the water and stirring of the mixture with the spindle bring them more frequently in contact with each other in a quarter of an hour, than they would be in several days in the common method; by which means the whole process is finished in about 24 hours. Less quicksilver is also lost by it; for being always covered with water, it cannot evaporate; and in well managed and successful operations, no quicksilver dust is produced: but the greatest recommendation is, that it is not attended with any loss of silver, so that even the poorest ores will yield all that they contain. Barba looks upon the profit of this method above the other to amount to 25 dollars for every heap of 50 quintals; even making allowance for the coals. The only objections are, that both silver and copper are apt to be lost by the corrosion of the copper-boilers: but if the copper be pure, there is no great reason to be apprehensive of any thing of this kind; or, at all events, the bottom of the boiler, which is constantly exposed to the action of the quicksilver, may be secured by a copper ring three or four inches high; and the bottom itself may be secured in the same manner; so that when corroded they may be changed for new ones: or the boilers may be paved or lined with varnishes or mortars of different kinds; which will as effectually prevent any loss. While the whole is boiling, the quicksilver violently seizes on the other metal; by which means the amalgam is filled with many heterogeneous particles. These are separated by washing in quicksilver, on the surface of which they swim like scoria, and may easily be taken off, till the quicksilver shows its usual brightness; and as this cannot be done without taking off some of the metals also, the scum may be reserved for the next operation. The advantage of amalgamation by boiling chiefly appears in this, that heaps, in which by too large additions, the quicksilver has been totally dissolved so as to disappear, may be easily cured by boiling them, in iron or copper vessels with bits of iron; for then the quicksilver appears again in its proper metallic form and brightness.

3. *Amalgamation in mortars.* It is difficult to pro-

cure the full produce from ores which contain native gold and silver either in the form of hair or wire, or in larger lumps and nodules. These cannot be completely pounded, nor can they be amalgamated; for the mercury will not dissolve the large particles of gold and silver; and when they are treated by fire, the stubborn nature of their matrices occasions a great loss of metal. The following method of treating them in a mortar was discovered by a Franciscan friar.

A round conical hole is cut in a hard stone, half a foot in diameter at top, of an equal depth, and sloping into a truncated, or rather obtuse and nearly flat bottom, of about four inches in diameter. Some quicksilver is poured into it, together with a proportional quantity of small bits of the native metal or ore; after which they are triturated with an iron pestle. By this violent trituration, the gold and silver combine with the quicksilver; and the finer, lighter stuff of red silver ore and other silver calces, which are generally found with native silver, runs off by means of a small launder and current of water. It is not, however, suffered to run away, but is left to settle for common amalgamation.

Mortars of the dimensions above described being too small for any considerable quantity of ore, Barba proposes to substitute in their place larger stones of a concave figure, with vertical grinders, as in oil-mills; or common horizontal and parallel grinders of the grist-mill. The ore and quicksilver are put between these stones, with a small stream of water; which, running off, will carry away the lighter stuff, whilst the gold and silver will remain at the bottom, taken up by the quicksilver.

There are several other methods of amalgamation described in Baron Born's work, as practised by the Spaniards of South America: but as all of them agree in the most material circumstances with those already mentioned, we shall only farther take notice of that invented by the Baron himself, and by him lately introduced at Shemnitz in Lower Hungary.

This method is very pompously related, and at great length, in his work on the subject. His theory contains the following particulars:

1. Quicksilver has a tendency to unite with other metals and semimetals, and to *quicken* or *animate* them according to certain laws of affinity which are determined by experience.

2. It unites with gold, silver, copper, tin, lead, bismuth, and zinc, without heat; but with other metals and semimetals it will not unite but in a state of fusion. It unites with tin and bismuth more easily than with gold and silver; and with these more readily than with copper.

3. The union of quicksilver with other metals is promoted by heat.

4. This union is also greatly promoted by mechanical comminution.

5. No amalgamation, or only a very slow and partial one, will take place, if the surface of the quicksilver or metallic particles be covered with a coat of heterogeneous matter; which happens chiefly in the amalgamation of ores where the fine particles of the metal are involved in sulphur and arsenic.

6. Hence it is necessary to free the noble metals

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from the stony matter which surrounds them, and to reduce the baser ones from their calciform to a metallic state, before they can be amalgamated with success.

7. Particles of gold and silver may be freed from the stony matters which involve them by trituration; and from sulphur and arsenic, by calcination.

8. In calcination, some part of the sulphur is destroyed, and vitriolic acid disengaged; which, combining with the earthy matters contained in the ore, as well as the calces of the baser metals mixed with it, still leave the gold and silver involved: whence it is necessary to employ such chemical agents as will free the particles of these metals from their heterogeneous coat, and keep their surface as well as that of the quicksilver clean, without acting either upon the gold or silver. These agents are principally the mineral acids, which act variously according to their different natures. The marine acid is most efficacious for gold or silver ores; but it would be exceedingly expensive to use it in its proper form, so that it is necessary to take some method of expelling it extemporaneously from common salt by means of oil of vitriol.

9. The calcined ore, when pulverised, must be wetted with water, for the purpose of dissolving the disengaged vitriolic acid and the earthy and metallic neutral salts, which are produced by it in proportion to the sulphur contained in the ore. Vitriol is produced by calcination only in this proportion; and hence if the ore does not naturally contain a sufficiency of sulphur to produce vitriol for the purpose of decomposition, it will be necessary to add something of this kind. Vitriol of copper or of iron will answer, but the former is preferable. If, therefore, the pulverised ore, which has once gone through the process of amalgamation, should still appear to contain gold or silver, mix it with some additional vitriol and common salt; leave it for some time to macerate by itself; and, at a second trituration with quicksilver, a considerable quantity of silver will be found in the amalgama which had not been extracted in the first, though common salt had been used in it. Thus the common salt may be decomposed in the wet way.

10. To decompose the common salt in the dry way, the ore must be properly stamped and sifted, and the mixtures made up with a proportional quantity of pulverised common or rock salt, and then undergo an adequate calcination in an open fire. Thus the common salt will be decomposed according to the nature of the mixture; either by the vitriolic acid produced by the decomposition of the sulphur, or otherwise.—The muriatic acid, thus disengaged, dissolves the heterogeneous particles in which the metals are involved; and allows the quicksilver to act upon them much more effectually than it could have been enabled to do by any mechanical comminution; and this the more so as it takes up even those particles of dephlogisticated iron upon which the other acids are incapable of acting.

11. The calcination and corrosion of the baser metals is indispensably necessary, especially in a natural combination of gold and copper; for the affinity of these two is so strong, that unless the latter be perfectly calcined, or otherwise removed, very little of the

gold can be extracted. The separation will also be promoted by the addition of sulphureous substances.

From these considerations, the Baron lays down the following rules concerning amalgamation.

“1. The ores and mixtures previous to their amalgamation must be mechanically comminuted, and reduced to a fine powder, by stamping, grinding, and sifting, that the surfaces of the particles, and their points of contact, may be increased and multiplied.

“2. This powder must be calcined, that, besides the pure particles of the nobler metals, those which are disguised in the ore may be disengaged and laid bare by desulphuration and calcination.

“3. If before its calcination no common salt was added, it must be added afterwards; then it must be triturated with a proportionate quantity of quicksilver and water, long enough, and in such a manner, that the quicksilver, by an uninterrupted motion of the whole mass, may come into repeated contact with the disengaged gold and silver particles, and take them up.

“4. As much depends on the just-mentioned proportions, the inspector, director, or master of the work, must be well acquainted with the elective attraction of bodies, that forming a just idea of, and judgment on, their different mechanical or chemical decomposition and combination, he may remedy and remove such untoward difficulties and impediments in the process as may, and will sometimes, prevent its full success.”

The various steps by which the metals are extracted from their ores, according to the Baron's method, are, 1. Stamping, grinding, and sifting. 2. Calcination; after which the grinding and sifting must be repeated. 3. Trituration. 4. Washing of the residuum. 5. Elutriation of the amalgama. 6. Heating of the same. 7. Distillation of the quicksilver pressed from the amalgam. 8. Refining of the heated amalgam. 9. Extracting from the residua such parts of the noble metals as may still be contained in them.

1. *Stamping, grinding, and sifting.* The Baron recommends dry-stamps and mills for this purpose; as wet-stamps, he says, “would bring on great loss of silver, and expensive contrivances to prevent or recover it.” On the other hand, E. Raspe, the translator of his work, says, that “late experiments have proved so much in favour of the wet-stamps, that they have actually been adopted as great improvements.”

The contents of the ores are accurately investigated by essays before any thing is done in the large way. The ores are delivered to the respective mills; the smaller ores are passed over a brass sieve, the meshes of which are about one-tenth of an inch wide, that the finer particles may be separated and not sent to the stamps, which would occasion some waste, especially in the dry way. The finer sand is sent directly to the mill, and the big lumps to the stamp. Each box, or set of stamps, has three stamp-heads, weighing 40 or 54 pounds, the sole being of cast-iron. The matter is every now and then wetted with water to prevent the finer parts from flying off. When the ore is sufficiently beat in the stamps, it is afterwards sifted, and the coarse part returned to the stamp. When the coarsest part is reduced in this manner to the size of coarse sand, it is sent to the mill; the running stone of which

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which must be kept close in a box, and nothing left open but the admission-funnel. The millstones are a kind of porphyry, and the sieves of brass-wire.

2. *Calcination.* The ore being reduced to a sufficient degree of fineness, is next carried to the calcining furnace; previous to which it is again to be tried by essay, and to have the proper additions according to its nature. When the furnace is properly heated, the whole quantity of ore destined to one furnace, about 30 quintals, is brought up to the top by wheel-barrows; and being spread as even as may be, the proper quantity of salt and lime is sifted over it, and the whole turned with crooks and rakes till it be perfectly mixed. The calcination is then performed in the following manner: The back-door being carefully shut, eight hundred weight of the matter, prepared as already mentioned, is let down through a funnel upon the upper hearth. Here it is again to be spread and allowed to dry before it is put down on the lower hearth; and as soon as this is done, another quantity is put upon the upper hearth, that the two operations may regularly succeed each other.

Our author describes at great length all the minutiae of this operation: but, as he justly observes, "Experience and practice are, and must be, the best teachers; for there are many things which must be attended to, and which words and descriptions will hardly make intelligible." We shall therefore only observe, that the calcining furnace must be kept heated day and night: but while the ore is shoved down from the upper to the lower hearth, the fire must be kept very moderate; and during the calcination it will be necessary to keep the matter constantly turning with iron rakes, the combs or teeth of which are from four to eight inches long.

The grinding and sifting after calcination is only necessary when the matter has run into hard indissoluble clots during the operation; and is performed in a grinding and sifting mill, which turns by water; but which it is unnecessary here to describe, as every possessor of mines would choose such mechanical contrivances as best suit his purpose.

3. *Trituration, boiling, and amalgamation.* After the ores have been properly calcined and pounded, the success of the amalgamation depends mostly on the proportions of quicksilver and water which are added to the stuff, and the construction of the stirring apparatus by which the whole is kept in constant motion and mutual contact. The lighter the stuff, the more voluminous and bulky it will prove, and consequently the gold and silver will be the more dispersed: in which case the quantity of quicksilver must be proportioned to the mass, that notwithstanding its constant gravitation towards the bottom it may the more frequently come into contact with the gold and silver. It acts in proportion to its bulk and surface. A larger quantity is therefore advisable, as it not only forms a larger surface on the bottom of the vessel, but comes likewise into contact with the gold and silver more frequently; nor is there any greater loss of quicksilver to be apprehended on that account. A larger proportion of fluid metal is in particular necessary when the matter is mixed with lead or antimony: for, by taking up the lead, it becomes proportionably less active and fit for the reception of gold and silver; and turning greasy

by the antimony, it must in the former case leave rich residua, and in the latter bring on greater loss. It is also determined by experience, that the excess of quicksilver never does any hurt, while too small a quantity never fails to be disadvantageous.

With regard to the construction of the boilers, it is needless to be particular, as those recommended by Alonso Barba seem to be very adequate to the purpose. Heat is required; but it is not necessary that the matter should boil, a moderate fire being sufficient for making the metals unite. Nor is there occasion for more water than what will make the matter liquid. The stirring apparatus is put in motion by the crank of a water wheel, and a horizontal rack with cogs; which, being properly fixed in a groove by cross bars, slides forward and backward on brass rollers and casters. The cogs of this rack catch into those of the perpendicular trundle and spindle of the stirrers, which turns round twice by three and an half feet motion of the sliding rack. The whole moves quicker or slower in proportion to the box of water thrown upon the wheel; and the quicker motion of the rack produces of course a quicker turn and better trituration. The stirrers must be circular segments corresponding with the sides and bottom of the boiler, otherwise their motion is irregular and unsatisfactory. The time of trituration, as depending on the nature of the ore, must be determined by experience.

4. *The washing of the triturated leavings or residuum* is performed in large tubs, and requires no particular description, farther than that it be continued till all the soluble matter be got out; and for this purpose there must be a contrivance for stirring the matter all the time it is washing.

5. *Eliguation of the quicksilver and amalgama.* Formerly this was performed in bags made of deer-skins, strongly compressed with engines for the purpose; but this being found too expensive, it is now done by small quantities at a time, and pressed only by the hand till the ball of amalgam yields no more quicksilver. A small quantity always remains in the quicksilver which passes through; and this quantity is the greater in proportion to the warmth of the amalgam when pressed.

6. *The distillation of the amalgam* is performed *per descensum* in large iron pots. The undermost stands upright to its middle in a stream of cold running water which passes under the hearth; the upper part hardly appearing two inches above it. The amalgam, made up into balls, is placed in iron cullenders fixed upon a tripod set in the bottom of the lower pot, and covered in the inside with a coarse cloth. The upper pot is inverted on the lower one; and the juncture being luted, the fire is put all round the outer one, and the heat passing through to the amalgam quickly liquefies it, and raises the quicksilver in vapour, which condenses in the under pot continually kept cool by the stream of water. The upper pot is kept in a strong red heat for five or six hours; by which means the cloth is entirely converted into tinder, so that the cullenders must afterwards be cleaned with a brass brush.

The other operations contain nothing particular but what may be easily understood from what has been already delivered.

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SECT. IV. *Ores of Copper.*

is known which does not contain a considerable quantity of arsenic.

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§ 1. COPPER is found under ground in three different forms: 1. Native or virgin copper diversely ramified, which is much more rare than native silver. This native copper is not so ductile as copper purified by fusions from the ore (A). 2. Copper is found in form of calx, of verdigrise, of precipitates. Such are the minerals called *filky copper ores*, and several white and green earths. These matters are only copper almost pure and but little mineralised, but which has been corroded, dissolved, precipitated, calcined by saline matters, by the action of the air, of water, and of earths (B). 3. Copper is frequently in a truly mineral state, that is, combined with sulphur and with arsenic, with other metallic matters mixed with earths, and enveloped in different matrices (C). These are the true copper ores. They have no regular forms except they partake of the nature of pyrites. Their colours are very different, which depend chiefly on the proportion of the mineral substances composing them. Lastly, in almost all of them we may perceive green or blue colours, which always indicate an erosion or calcination of the copper. Most copper ores contain also some iron or ferruginous earth, to which the ochrey colour is to be attributed, which might make us believe them to be ores of iron. Ores which contain much iron are the most difficultly fusible.

Copper ores have almost all a yellow, golden, and shining colour, by which they are easily distinguished. Some of them are coloured with irises, and frequently have spots of verdigrise, by which also they are distinguishable from other ores.

Many copper ores are also rich in silver. Such is that called the *white copper ore*, the colour of which is rather occasioned by arsenic than by silver, although it contains so much silver as to be enumerated by several mineralogists amongst silver ores.

Lastly, the pyrites of a golden yellow colour which contains copper and sulphur, and the white pyrites which contains copper and arsenic, are considered as copper ores by several chemists and naturalists. Hencckel and Cramer remark, that no proper ore of copper

§ 2. *Ores of copper* may be assayed in methods similar to those employed for smelting of large quantities of ores (Part III.), or they may in general be assayed by the following processes.

P R O C E S S I.

To reduce and precipitate copper from a pure and fusible ore in a close vessel.

“Mix one, or, if you have small weights, two decimastical centners of ore beat extremely fine, with six centners of the black flux; and having put them into a crucible or pot, cover them one inch high with common salt, and press them down with your finger: but let the capacity of the vessel be such that it may be only half full; shut the vessel close, put it into the furnace; heap coals upon it, so that it may be covered over with them a few inches high; govern the fire in such a manner that it may first grow slightly red-hot. Soon after you will hear your common salt crackle; and then there will be a gentle hissing noise. So long as this lasts, keep the same degree of fire till it is quite over. Then increase suddenly the fire, either with the funnel and cover put upon the furnace, or with a pair of bellows applied to the hole of the bottom part, that the vessel may grow very red-hot. Thus you will reduce and precipitate your copper in about a quarter of an hour: then take out the vessel, and strike with a few blows the pavement upon which you put it, that all the small grains of copper may be collected in one mass.

“Break the vessel, when grown cold, in two, from top to bottom, as nearly as you can: if the whole process has been well performed, you will find a solid, perfectly yellow and malleable regulus adhering to the bottom of the vessel, with scorias remaining at top of a brown colour, solid, hard, and shining, from which the regulus must be separated with several gentle blows of a hammer; this done, weigh it, after having wiped off all the filthiness.

A soft, dusty, and very black scoria, is a sign of a fire not sufficiently strong. Small neat grains of copper

(A) *Native copper* is solid; or consisting of friable masses, formed by precipitation of cupreous vitriolic waters, called *cement* or *ziment copper*; or forming crystallized cubes or grains, leaves, branches, or filaments.

(B) *Calcareous ores* are either pure calces of copper, or are mixed with heterogeneous matters. 1. The *pure* are loose friable ochre, called *caeruleum montanum* “mountain-blue,” and *viride montanum* “mountain-green;” and the *red indurated calx*, called improperly *glass copper ore*. 2. *Mixed calcareous ores* are those in which the calx of copper is mixed; with *calcareous earth*, forming a mountain-blue; with *iron*, forming a black calx; with *gypsum*, an indurated green ore, called *malachites*; and with *quartz*, a red ore.

(C) Copper is *mineralised*, 1. By *sulphur*, forming the *grey copper ore*, improperly called *vitreous* (*minera cupri vitrea Wallerii*). 2. By *sulphurated iron*, forming the *hepatic copper ore* (*minera cupri hepatica Wallerii*) of a brown yellow colour. It is a kind of cupreous pyrites, and is called by Cronstedt *minera cupri pyritacea*. Sometimes it is of a blackish grey colour, and is then called *pyrites cupri griseus* (*minera cupri grisea Wallerii*); sometimes of a reddish yellow, and tarnished with blue irises on its surface, when it is called *minera cupri lazurea*; when of a yellowish green colour, it is the *pyrites cupri flavo-viridescens* (*cuprum sulphure et ferro mineralisatum Wallerii*); and when of a pale yellow colour, it is the *pyrites cupri pallide flavus*. Most of the above pyritaceous ores contain also some arsenic, but their sulphur is predominant. 3. *Copper mineralised by sulphur, iron, and arsenic*. *White copper ore* (*Minera cupri alba Wallerii*). This ore contains also some silver. 4. *Copper dissolved by vitriolic acid*. *Native blue vitriol*. 5. *Copper united with bitumens*. *Copper-coal ore*. This is a pit-coal, from the ashes of which copper is obtainable. 6. Copper is also found in the mineral called *kupfer nickel*.

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of per reduced but not precipitated, and adhering still to scorias, especially not very far from the bottom, and an unequal and ramificated regulus, are signs of the same thing. A solid, hard, shining, red-coloured scoria, especially about the regulus, or even the regulus itself when covered with a like small crust, are signs of an excess in the degree and duration of the fire.

Remarks. All the ores which are easily melted in the fire are not the objects of this process; for they must also be very pure. Such are the vitreous copper ores." (Mr Cramer means, it is presumed, the red calciform ore, called improperly *glass ore*, and not the *minera cupri vitrea* of Wallerius, which being composed of copper mineralised by sulphur, could not be treated properly by this process, in which no previous roasting is required. The sulphur of this ore would with the alkali of the black flux form a hepar, from which the metal would not precipitate). "But especially the green and azure-coloured ores, and the *ceruleum* and *viride montanum*, which are not very different from them. But if there is a great quantity of arsenic, sulphur, or of the ore of another metal and semimetal joined to the ore of copper, then you will never obtain a malleable regulus of pure copper, tho' ores are not always rendered refractory by the presence of these."

P R O C E S S II.

To reduce and precipitate copper out of ores rendered refractory by earth and stones that cannot be washed off.

"BEAT your ore into a most subtile powder, of which weigh one or two centners, and mix as much sandiver to them. This done, add four times as much of the black flux with respect to the ore; for by this means, the sterile terrestrial parts are better disposed to a scorification, and the reducing and precipitating flux may act more freely upon the metallic particles freed from all their incumbrances.

"As for the rest, make the apparatus as in last process: but you must make the fire a little stronger for about half an hour together. When the vessel is grown cold and broken, examine the scorias, whether they are as they ought to be. The regulus will be as fine and ductile as the foregoing.

Remarks. As these copper ores hardly conceal any sulphur and arsenic in them, the roasting would be of no effect, and much copper would be lost. For no metallic calx, except those of gold and silver, improperly so called, can be roasted, without you find a part of the metal lost after the reduction.

P R O C E S S III.

To precipitate copper out of an ore (D) that contains iron.

"Do all according to last process. But you will find, after the vessel is broken, a regulus upon no account so fine, but less ductile, wherein the genuine colour of the copper does not perfectly appear, and which must be further purified,

Remarks. The fire used in this operation is not so strong that the iron should turn to a regulus. But as copper is the menstruum of iron, which is of itself very refractory in the fire; for this reason, while the ore and the flux are most intimately mixed and confounded by trituration, the greatest part of the iron being dissolved by the copper, turns into a regulus along with it."

P R O C E S S IV.

The roasting of a pyritose, sulphureous, arsenical, semimetallic, copper ore.

"BREAK two docimastical centners of the ore to a coarse powder, put them into a test covered with a tile, and place them under the muffle of a docimastical furnace. But the fire must be so gentle, that the muffle may be but faintly red-hot. When the ore has decrepitated, open the test and continue the fire for a few minutes; then increase it by degrees, that you may see the ore perpetually smoking a little: in the mean time, it is also proper now and then to stir it up with an iron hook. The shining particles will assume a dark red or blackish colour. This done, take out the test, that it may grow cold. If the small grains are not melted, nor strongly adherent to each other, hitherto all will be well; but if they run again into one single cake, the process must be made again with another portion of the ore, in a more gentle fire.

"When the ore is grown cold, beat it to a powder somewhat finer, and roast it by the same method as before; then take it out, and if the powder is not melted yet, beat it again to a most subtile powder; in this you are to take care that nothing be lost.

"Roast the powder in a fire somewhat stronger, but for a few minutes only. If you do not then find the ore any way inclined to melt, add a little tallow, and burn it away under the muffle, and do the same another time again, till the fire being very bright, you no longer perceive any sulphureous, arsenical, unpleasant smell, or any smoke; and there remains nothing but a thin, soft powder, of a dark red, or blackish colour.

Remarks. Every pyrites contains iron, with an unmetallic earth; to which sulphur or arsenic, and most commonly both, always join. Besides, there is copper in many pyrites; but sometimes more and sometimes less: some of them are altogether destitute of copper; therefore, so much as pyrites differ with regard to the proportion of their constituent particles, so much do they differ as to their disposition in the fire. For instance, the more copper there is in pyrites, the more it inclines to colliquation. The more sulphur and arsenic it has in it, the more quickly the melting of it will be procured, and the reverse: the more iron and unmetallic earth it contains, the more it proves refractory in the fire. Now if such pyrites melt in the roasting, as happens to some of them if they grow but red-hot, the sulphur and arsenic that lies hidden therein are so strictly united with the fixed part, that you would in vain attempt to dissipate them.

Nay,

(D) Mr Cramer still means the calciform ores only, and not the mineralised ores of copper.

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Nay, in this case, when it is reduced again into a powder, it requires a much greater time and accuracy in the regimen of the fire to perform the operation. For this reason, it is much better to repeat it with new pyrites. But you can roast no more than the double quantity at once of the ore you have a mind to employ in the foregoing experiment; to the end that, the precipitation by fusion not succeeding, there may remain still another portion entire; lest you should be obliged to repeat a tedious roasting. If you see the signs of a ferreous refractory pyrites, the operation must be performed with a greater fire, and much more quickly. However, take care not to do it with too violent a fire: for a great deal of copper is consumed not only by the arsenic, but also by the sulphur; and this happens even in vessels shut very close, when the sulphur is expelled by a fire not quite so strong; which a reiterated and milder sublimation of the sulphur in a vessel both very clean and well closed will clearly show.

"When the greatest part of the sulphur and the arsenic is dissipated by such causes as promote colliquation, you may make a stronger fire: but then it is proper to add a little of some fat body; for this dissolves mineral sulphur: it changes the mixture of it in some part, which, for instance, consists in a certain proportion of acid and phlogiston; and at the same time hinders the metallic earth from being reduced into copper, by being burnt to an excess. From these effects, the reason is plain, why assayers produce less metals in the trying of veins of copper, lead, and tin, than skilful smelters do in large operations. For the former perform the roasting under a muffle, with a clear fire, and without any oily reducing menstruum; whereas the latter perform it in the middle of charcoal or of wood, which perpetually emit a reductive phlogiston.

"The darker and blacker the powder of the roasted ore appears, the more copper you may expect from it. But the redder it looks, the less copper and the more iron it affords; for roasted copper dissolved by sulphur or the acid of it is very black, and iron, on the contrary, very red.

PROCESS V.

The precipitation of copper out of roasted ore of the last process.

"Divide the roasted ore into two parts: each of them shall go for a centner: add to it the same weight of sandiver, and four times as much of the black flux, and mix them well together. As for the rest, do all according to the process I.: the precipitated regulus will be half malleable, sometimes quite brittle, now and then pretty much like pure copper in its colour, but sometimes whitish, and even blackish. Whence it is most commonly called *black copper*, though it is not always of so dark a dye.

"It is easy to conceive, that there is as great a difference between the several kinds of that metal called *black copper*, as there is between the pyritose and other copper ores accidentally mixed with other metallic and semi-metallic bodies. For all the metals, the ores of which are intermixed with the copper ores, being reduced, are precipitated together with the

copper, which is brought about by means of the black flux. Wherefore iron, lead, tin, the reguline part of antimony, bismuth, most commonly are mixed with black copper in a multitude of different proportions. Nay, it is self-evident, that gold and silver, which are dissolvable by all these matters, are collected in such a regulus when they have been first hidden in the ore. Besides, sulphur and arsenic are not always altogether absent. For they can hardly be expelled so perfectly by the many preceding roastings, but there remain some vestiges of them, which are not dissipated by a sudden melting, especially in a close vessel, wherein the flux swimming at top hinders the action of the air. Nay, arsenic is rather fixed by the black flux, and assumes a reguline semi-metallic form, while it is at the same time preserved from dissipating by the copper.

PROCESS VI.

To reduce black copper into pure copper by scorification.

"SEPARATE a specimen of your black copper, of the weight of two small docimastical centners at least; and do it in the same manner, and with the same precautions, as if you would detect a quantity of silver in black copper.

"Then with lute and coal-dust make a bed in the cavity of a test moistened: when this bed is dry, put it under the muffle of the docimastical furnace, in the open orifice of which there must be bright burning coals, wherewith the test must likewise be surrounded on all parts. When the whole is perfectly red-hot, put your copper into the fire, alone, if it contains lead; but if it is altogether destitute of it, add a small quantity of glass of lead, and with a pair of hand-bellows increase the fire, that the whole may melt with all speed; this done, let the fire be made a little violent, and such as will suffice to keep the metallic mass well melted, and not much greater. The melted mass will boil, and scorias will be produced, that will gather at the circumference. All the heterogeneous matters being at last partly dissipated, and partly turned to scorias, the surface of the pure melted copper will appear. So soon as you see it, take the pot out of the fire, and extinguish it in water: then examine it in a balance; and if lead has been at first mixed with your black-copper, add to the regulus remaining of the pure copper one 15th part of its weight which the copper has lost by means of the lead, then break it with a vice; and thus you will be able to judge by its colour and malleability, and by the surface of it after it is broken, whether the purifying of it has been well performed or no. But whatever caution you may use in the performing of this process, the product will nevertheless be always less in proportion than what you can get by a greater operation, provided the copper be well purified in the small trial.

"Remarks. This is the last purifying of copper, whereby the separation of the heterogeneous bodies begun in the foregoing process is completed as perfectly as it possibly can be. For, except gold and silver, all the other metals and semimetals are partly dissipated and partly burnt, together with the sulphur and arsenic. For in the fusion they either turn of themselves to scoria or fumes, or this is performed by means of iron,

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iron, which chiefly absorbs semimetals, sulphur, and arsenic, and the destruction of it is at the same time accelerated by them. Thus the copper is precipitated out of them pure; for it is self-evident, that the un-metallic earth is expelled, the copper being reduced from a vitrescent terrestrial to a metallic state, and the arsenic being dissipated by means of which the said earth has been joined to the coarser reguluses of the first fusion. But there is at the same time a good quantity of the copper that gets into the scorias: however, a great part of it may be reduced out of them by repeating the fusion.

“The fire in this process must be applied with all imaginable speed, to make it soon run: for if you neglect this, much of your copper is burnt; because copper that is only red-hot, cleaves much sooner, and in much greater quantity, into half-scorified scales, than it is diminished in the same time when melted. However, too impetuous a fire, and one much greater than is necessary for the fusion of it, destroys a much greater quantity of it than a fire sufficient only to put it in fusion would do. For this reason, when the purifying is finished, the body melted must be extinguished in water together with the vessel, lest, being already grown hard, it should still remain hot for a while; which must be done very carefully to prevent dangerous explosions.

“The scoria of the above process frequently contains copper. To extract which, let two or three decimassical centners of the scoria, if it be charged with sulphur, be beat to a subtile powder, and mix it, either alone, or, if its refractory nature requires it, with some very fusible common pounded glass without a reducing saline flux, and melt it in a close vessel, and in a fire having a draught of air; by which you will obtain a regulus.

“But when the scoria has little or no sulphur at all in it, take one centner of it, and with the black flux manage it as you do the fusible copper ore, (process I.) by which you will have a pure regulus.”

PROCESS VII.

The following process is translated from Mr Gellert's *Elements of Assaying*, and describes a new method of assaying ores, concerning which, see the section *Of Assaying in general*, p. 338. col. 2.

To assay copper ores.

ROAST a quintal of ore [in the manner described in process IV.]: add to it an equal quantity of borax, half a quintal of fusible glass, and a quarter of a quintal of pitch: put the mixture in a crucible, the inner surface of which has been previously rubbed with a fluid paste of charcoal dust and water: cover the whole with pounded glass mixed with a little borax, or with decrepitated sea-salt: put a lid on the crucible, which you will place in an air-furnace, or in a blast-furnace: when the fire shall have extended to the bottom of the coals, let it be excited briskly during half an hour, that the crucible may be of a brisk red colour: then withdraw the crucible, and when it is cold break it: observe if the scoria be well made: separate the regulus, which ought to be semi-ductile; and weigh it. This regulus is black copper; which must be purified, as in process VI.

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If the ore be very poor, and enveloped in much earthy and stony matters; to a quintal of it, a quintal and a half of borax, a quarter of a quintal of pitch, and ten pounds of calx of lead or minium, must be added. The calx of lead will be revived, and will unite with the scattered particles of the copper, and together with these will fall to the bottom of the crucible, forming a compound regulus. When the ores of copper are very rich, half a quintal of borax and a quarter of a quintal of glass will be sufficient for the reduction. If the ore is charged with much antimony, a half or three quarters of a quintal of clean iron-filings may be added; otherwise the large quantity of antimony might destroy the copper, especially if the ore contained no lead. If iron be contained in copper ore, as in pyrites, some pounds of antimony, or of its regulus, may be added in the assay; as these substances more readily unite with iron than with copper, and therefore disengage the latter metal from the former.

PROCESS VIII.

To assay ores of copper by humid solution.

SOME pyrites and ores contain so small a quantity of copper, that it cannot be separated by the above processes; but is destroyed by the repeated roastings and fusions. These, and indeed any copper-ores, may be assayed by humid solution, or by menstruums.

1. By roasting a sulphureous ore, the sulphur is burnt or decomposed, its phlogiston with part of the acid evaporating, while the remaining part of the acid combines with the metals, especially with the copper and iron contained in the ore. Accordingly, from an ore thus roasted, a vitriolic solution may be obtained by lixiviation with warm water, especially if the ore has been exposed, during a few days after it has been roasted, to a moist air; as the water thus gradually applied unites better with the combination of the metallic calxes with the concentrated vitriolic acid of the sulphur: but all the copper is not thus reduced by one operation to a vitriol. More sulphur must therefore be combined with the residuous ore by fusion, and must be again burnt off, that the remaining part of the copper may be attacked by some of the acid of the sulphur. By repeating this operation, almost all the copper and iron will be reduced to a vitriolic lixivium, from which the copper may be separated and precipitated by adding clean pieces of iron.

2. Copper-ores may be more easily assayed by humid solution in the following manner:

Roast the mineralised ores in the manner directed in Process IV. and pulverise them. If the ores be calciform, they do not require a previous roasting. Put this powder into a matrafs capable of containing ten times the quantity of the ore; pour upon the ore some water: set the matrafs in a sand-bath, that the water may boil: pour off the lixivium: add to the residuous ore more water, with some vitriolic or marine acid: digest as before in the sand-bath, and add this lixivium to the former: repeat this operation, till you find that the acid liquor dissolves no more metal.

By adding clean plates of iron you may precipitate the copper, which ought then to be collected, fused with a little borax and charcoal dust, and weighed.

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We may remark, that although copper is not soluble by a dilute vitriolic acid, yet the calx of it obtained by roasting the ore, and also the calciform ores, are readily soluble in that acid.

3. Stahl advises to essay copper ores by boiling them, after they have been roasted and powdered, in water, together with tartar and common salt, or with alum and common salt: but we have not found this method so effectual as the preceding.

P R O C E S S IX.

Dr Fordyce's method of assaying copper ores, by means of aqua regia. [Phil. Trans. for 1781, vol. lxxx. art. 3.]

THIS method consists only in pouring a quantity of an aqua regia composed of equal parts of the nitrous and muriatic acids upon a small quantity of the ore in powder, till a fresh effusion of the menstruum shows no green or blue tinge; by which means all the metalline part of the ore will be dissolved. It is then to be precipitated by means of a solution of fixed alkali, or volatile alkali cautiously managed will answer the same purpose. The metal then appears in form of a green precipitate called *green verditer*; but is mixed with what calcareous earth might have been contained in the ore; which the acids would dissolve, and the fixed alkali, if that kind was used, would precipitate. The caustic volatile alkali would not throw down this earth, and is therefore to be preferred to any other; but care must be taken to hit the point of saturation very exactly with it, as it violently dissolves the metal if added in too great quantity. Dr Fordyce orders this green calx to be dissolved in vitriolic acid, and then, by adding a piece of clean iron to the solution, all the copper contained in the ore will be obtained in its metallic form.

This method can be subject to no fallacy, unless the ore contains a luminous matter; in which case some of the earth of alum will be mixed with the metal, as that earth will be precipitated by fixed alkali, by caustic volatile alkali, and by iron. This, however, may very effectually be prevented by dissolving the green calx first in volatile alkali, and then in vitriolic acid. It is even probable, that by reducing the ore to a very fine powder, and treating it with caustic alkali, all the metal might be separated from the ore, without the trouble of using aqua regia. For the principles on

which this method is conducted, see the article CHEMISTRY *passim*.

Ores of
Lead.

SECT. V. Ores of Lead.

§ 1. LEAD is seldom found native (E) and malleable. Neither, says Mr Macquer (F), is it found in form of calx or precipitate, as copper is, because it is much less liable to lose its phlogiston by the action of air and water: therefore almost all lead is found naturally mineralised.

Lead is generally mineralised by sulphur (G). Its ores have a dark white, but a shining metallic colour. These ores, although they form irregular masses, are internally regularly disposed, and seem to be composed of cubes of different sizes applied to each other, but not adherent. These ores are generally distinguished by the name of *Galena*. They commonly contain about three quarters of lead and a quarter of sulphur. They are accordingly heavy and fusible, although much less so than pure lead.

Most lead-ores contain silver; none but those of Willsch in Corinthia are known to be quite free from it: some of them contain so much of it, that they are considered as improper ores of silver. The smaller the cubes of galena are, the larger quantity of silver has been remarked to be generally contained.

§ 2. *Lead ores may be assayed.* 1. By means of the black flux, in the manner directed by Mr Cramer, as follows:

“Let one or more quintals of this ore be grossly powdered, and roasted in a test till no more sulphureous vapours be exhaled, and then reduced to a finer powder; it is then to be accurately mixed with twice its weight of black flux, a fourth part of its weight of clean filings of iron and of borax. The mixture is to be put into a good crucible, or rather into a test; it is then to be covered with a thickness of two or three fingers of decrepitated sea-salt; the crucible is to be closed, and placed in a melting furnace, which is to be filled with unlighted charcoal, so that the top of the crucible shall be covered with it. Lighted coals are then to be thrown upon the unkindled charcoal, and the whole is left to kindle slowly, till the crucible be red-hot; soon after which a hissing noise proceeds from the crucible, which is occasioned by the reduction of the lead: the same degree of fire is to be maintained while this noise continues, and is afterwards to be suddenly

(E) Cronstedt doubts whether any native lead has been found. Linnæus says, he has seen what externally appeared to be such.

(F) But he is mistaken. As lead unites strongly with vitriolic acid, we might expect to meet ochres of this metal as well as of copper. Accordingly, we find some calciform ores of lead. 1. A pure calx of lead, in form of a friable ochre, *cerussa nativa*, found on the surface of galena; or it is indurated with a radiated or fibrous texture, of a white or yellowish green colour, and resembling spar; it is called *spatum plumbi*, *sparry lead-ore*, and *lead-spar*. 2. A calx of lead is found mixed with calx of arsenic, forming the ore called *arseniated lead spar*. Sometimes also that calx is mixed with calcareous earth.

(G.) Lead is mineralised, 1. With sulphur; such are the several kinds of steel-grained and tessellated galenas, which also contain generally some silver. 2. With sulphurated iron and silver. It is fine-grained or tessellated, and is distinguished from the former by yielding a black slag when scorified, whereas the former yields a yellow slag. 3. With sulphurated antimony and silver. *Plumbum sibiatum Linnæi*. Its colour is similar to that of galena, and its texture is striated. 4. With sulphur and arsenic. This ore is soft, almost malleable, like lead. From this ore lead may be melted by the flame of a candle.

Ores of Tin denly increased, so as to make a perfect fusion; in which state it is to be continued during a quarter of an hour; after which it is to be extinguished; and the operation is then finished." The filings of iron are added to the mixture to absorb the sulphur; a certain quantity of which generally remains united with the lead-ore, notwithstanding the roasting. We need not fear lest this metal should unite with the lead and alter its purity; because, although the sulphur should not hinder it, these two metals cannot be united. The refractory quality of the iron does not impede the fusion; for the union it forms with the sulphur renders it so fusible, that it becomes itself a kind of flux. This addition of iron in the essay of lead-ores would be useless, if the ores were sufficiently roasted, so that no sulphur should remain.

Or, 2. By the following process of Mr Gellert.

"Mix a quintal of roasted lead-ore with a quintal of calcined borax, half a quintal of glass finely pulverised, a quarter of a quintal of pitch, and as much of clean iron-filings: put this mixture into a crucible wetted with charcoal-dust and water: place the crucible before the nozzle of the bellows of a forge, and when it is red raise the fire during 15 or 20 minutes; then withdraw the crucible, and break it when cold."

Some very fusible ores, such as the galena of Derbyshire, may be essayed, as large quantities of it are smelted, without previous roasting, and without addition, merely by fusion during a certain time. For this purpose nothing more is requisite than to keep the ore melted in a crucible with a moderate heat, till all the sulphur is destroyed, and the metal be collected. To prevent the destruction of any part of the metal after it is separated from the sulphur, some charcoal dust may be thrown over the ore, when put into the crucible; but if the galena be mixed with pyrites, especially arsenical pyrites, it requires much roasting and saline fluxes.

SECT. VI. *Tin Ores.*

§ 1. TIN is very seldom found pure, but almost always mineralised, and chiefly by arsenic.

The richest ore of tin is of an irregular form, of a black or tarnished colour, and almost the heaviest of all ores. The cause of this extraordinary weight is, that it contains much more arsenic than sulphur, whereas most ores contain more sulphur than arsenic.

The most common tin ore is of the colour of rust, which proceeds from a quantity of iron or of iron-ore mixed with it. The tin-ores of Saxony and Bohemia appear to be all of this kind.

One kind of tin-ore is semi-transparent and like spar. Lastly, several kinds of garnets are enumerated by mineralogists among tin-ores, because they actually contain tin.

The county of Cornwall, in England, is very rich in tin-ores; and the tin contained in them is very pure. From tin-mines in the East Indies tin is brought, called *Malacca tin*. No mines of tin have been discovered in France; only in Bretagne garnets are found which contain some tin.

Native tin is said to have been found in Saxony and Malacca. Its ores are all of the calciform kind, ex-

cepting black-lead, which appears to be tin mineralised by sulphur and iron.

The calciform ores of tin are, 1. Tin-stone, which is of a blackish-brown colour, and of no determinate figure; and tin-grains, or crystals of tin, which resemble garnets, and are of a spherical or polygonal figure, which they have probably acquired by the attrition of their angles. The tin-stone seems to consist of attrited tin-grains. This ore is calx of tin united with calx of arsenic, and frequently with calx of iron. 2. Garnets are said to contain calx of tin united with calx of iron. 3. Manganese is said also to contain tin.

§ 2. *Ores of tin may be essayed* in the same manner, according to Cramer, as he directed for the essay of lead-ores, *supra*. He further makes upon this essay the following remarks.

1. Tin-ore, on account of its greater gravity, admits better of being separated, by elutriation or washing, from earths, stones, and lighter ores. 2. A most exact separation of earths and stones ought to be made, because the scorification of these by fluxes require such a heat as would destroy the reduced tin. 3. The iron ought to be separated by a magnet. 4. By a previous roasting, the arsenic is dissipated, which would otherwise carry off a great deal of tin along with it in a melting heat, would change another part of it into ashes, and would vitiate the remaining tin. 5. The essay of tin is very precarious and uncertain; because tin once reduced is easily destructible by the fire, and by the saline fluxes requisite for the reduction.

Mr Gellert directs, that ores of tin should be essayed in the following manner:

"Mix a quintal of tin-ore, washed, pulverised, and twice roasted, with half a quintal of calcined borax, and half a quintal of pulverised pitch: these are to be put into a crucible moistened with charcoal-dust and water, and the crucible placed in an air-furnace: after the pitch is burnt, give a violent fire during a quarter of an hour; and then withdraw your crucible. If the ore be not very well washed from the earthy matters, as it ought to be, a larger quantity of borax is requisite, with some powdered glass, by which the too quick fusion of the borax is retarded, and the precipitation of the earthy matters is prevented. If the ore contains iron, to the above mixture may be added some alkaline salt.

SECT VII. *Ores of Iron.*

§ 1. IRON is seldom found in its metallic state, and free from admixture; though Cramer gives an account of an ore which needs only to be put into a forge, and heated to a welding heat. Several sands and earths also have the appearance of iron, and are even attractable by a magnet. The ore mentioned by Cramer is found vitrified: with moderate blows the scorias are thrown out, and a mass of iron obtained, which, by being put into the forge again, gives tough iron without any other process. But in general this metal is found in the state of a calx; or, though it is combined with a great quantity of the principle of inflammability, it has seldom enough of the metallic form; and it is very often intermixed with a certain proportion of sulphur. The minerals wrought for iron are three, *viz.* iron-ore, iron-stone, and bog-ore.

Ores of Iron

The iron ore is found in veins as the ores of other metals are, and the appearance is very various; sometimes it has a rusty iron colour resembling that of iron; sometimes it has a reddish cast; often it is formed into a sort of crystallizations which are protuberant knobs on the outside; and these consist of fibres tending to a common centre: and it is of a dark colour like coagulated blood. It is called *hematites* or *blood-stone*; and consists of a calx of iron with a small quantity of vitriolic acid.

Iron-stone in this country is clay found in strata with coal; but which contains a large quantity of iron, so as to make the working profitable. Sometimes it has little appearance of iron; but when burnt with a certain degree of heat, it becomes of a deep red.

The bog-ore is an ochre of iron, and is found generally in low situations, and in springs containing a small quantity of iron, which flowing over these grounds deposits it in the form of ochre; and after a number of ages it proves a rich mine of iron, and it is extracted from a calx of this kind in many parts of the world. There is also a particular kind of spar found in different countries of a pale blue colour, so that from its first appearance we would expect copper; but it contains a small quantity of iron, and is a combination of the metal with inflammable matter, as in Prussian blue.

The loadstone is a noted iron ore. It is always found in veins, and it is alleged that it is only possessed of its magnetic qualities when near the surface. In appearance, it does not differ from many of the ores of iron, and treated as an ore, it affords a considerable quantity of metal.

Neither is iron generally mineralised so distinctly as other metals are, unless in pyrites and ores of other metals.

Most of the minerals called *iron ores* have an earthy, rusty, yellowish, or brownish appearance, which proceeds from the facility with which the true iron ores are decomposed.

Iron is the most common and most abundant of all metals. In Europe, at least, we cannot find an earth, a sand, a chalk, a clay, a vitrifiable or calcinable stone, or even the ashes of any substance, which do not contain an earth convertible into iron. All earths and stones which are naturally yellow or red, and all those which acquire these colours by calcination, receive them from the ferruginous earth mixed with them. The yellow and red ochres consist almost solely of this earth: the black and heavy sands are generally very ferruginous.

The iron ore most commonly found is a stone of the colour of rust, of an intermediate weight betwixt those of ores in general and of unmetallic stones. This ore has no determinate form, and easily furnishes an iron of good quality.

Blood-stone or hematites, sanguine or red-chalk, and emery, are iron ores; some of which, for instance blood-stone, are almost all iron. Most of these substances require but a slight calcination to be rendered very attractable by a magnet, and soluble in aquafortis; but the iron obtained from them is of a bad quality, and they are therefore neglected. Iron from

the hematites is very brittle; that obtained from ochres is red-short. All these iron ores are so refractory, that they can scarcely be fused.

Iron ores are very various in their form; or rather they have no determinate form. Sometimes they are earths, sometimes stones, sometimes grains. Accordingly, those naturalists who attend only to the external form of things in classing and subdividing minerals, have been obliged to multiply the names of iron ores: hence they are called *iron ores in form of pease, of beans, of coriander seeds, of pepper-corns, of cinnamon, &c.* which Mr Cramer treats as ridiculous trifles.

§ 2. Ores of iron may be assayed by the following process:

P R O C E S S I.

[*CRAMER'S Art of Assaying, Proc. 54.*]

To reduce a precipitate iron out of its ore in a close vessel.

“ROAST for a few minutes in a test under a muffle, and with a pretty strong fire, two centners of the small weight of your iron ore grossly pulverised; that the volatiles may be dissipated in part, and the ore itself be softened in case it should be too hard. When it is grown cold, beat it extremely fine, and roast it a second time, as you do the copper-ore, but in a much stronger fire, till it no longer emits any smell; then let it grow cold again. Compose a flux of three parts of the white flux, with one part of fusible pulverised glass, or of the like sterile un sulphureous scorias, and add sandiver and coal-dust, of each one-half part; add of this flux three times the quantity of your roasted ore, and mix the whole very well together; then choose a very good crucible, well rubbed with lute within, to stop the pores that may be here and there unseen; put into it the ore mixed with the flux; cover it over with common salt; and shut it close with a tile, and with lute applied to the points.

“Put the wind-furnace upon its bottom-part, having a bed made of coal-dust. Introduce besides into the furnace a small grate supported on its iron bars, and a stone upon it, whereon the crucible may stand as on a support: surround the whole with hard coals, not very large, and light them at top. When the vessel begins to grow red, which is indicated by the common salt's ceasing to crackle, stop with gross lute the holes of the bottom part, except that in which the nozzle of the bellows is received: blow the fire, and excite it with great force, adding now and then fresh fuel, that the vessel may be never naked at top: having thus continued your fire in its full strength for three quarters of an hour, or for a whole hour, take next the vessel out of it, and strike several times the pavement upon which it is set, that the small grains of iron which happen to be dispersed may be collected into a regulus, which you will find after having broken the vessel.

“When the regulus is weighed, try its malleability: then make it red-hot; and when so, strike it with a hammer: if it bears the strokes of a hammer, both when red-hot and when cold, and extends a little, you may pronounce your iron very good; but if, when either

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Ores of Iron

Effaying of Ores of Iron either hot or cold, it proves brittle, you may judge it to be not quite pure, but still in a semi-mineral condition.

Remarks. The arsenic, but especially the sulphur, must be dissipated by roasting: for the former renders the iron brittle; and the latter not only does the same, but, being managed in a close vessel, with a saline alkaline flux, turns to a liver of sulphur; to the action of which iron yielding in every respect, it can upon no account be precipitated; and if not the whole, a great part of it at least is retained by the sulphureous scoria; so that in this case you commonly in vain look for a regulus.

"The iron obtained from this first precipitation has hardly ever the requisite ductility, but is rather brittle: the reason of which is, that the sulphur and arsenic remain in it; for notwithstanding that the greatest part of these is dissipated by roasting, yet some part adheres so strictly, that it can never be separated but with absorbent, terrestrial, alkaline ingredients, that change the nature of the sulphur. For which reason, in larger operations, they add quicklime, or marble stones that turn into quicklime; which, while they absorb the said minerals, are, by it, and by help of the destroyed part of the iron, brought to a fusion, and turn to a vitrified scoria; although, at other times, they resist so much by their own nature a vitrification. Another cause of the brittleness of iron is the unmetallic earth, when it is not yet separated from it; for the iron ore contains a great quantity of it, and in the melting remains joined with the reguline part: whence the iron is rendered very coarse and brittle. Some iron ores are altogether untractable: nevertheless, the reguluses produced out of them, when broken, have sometimes a neat semimetallic look; which proceeds undoubtedly from a mixture of a small quantity of some other metal or semimetal."

PROCESS II.

[The following Process for assaying iron ores, and ferruginous stones and earths, is extracted from Mr Gellert's *Elements of Effaying*.]

"ROAST two quintals of iron ore, or of ferruginous earth: divide the roasted matter into two equal parts: to each of which add half a quintal of pulverised glass, if the substance be fusible and contain much metal; but if otherwise, add also half a quintal of calcined borax. If the roasting has entirely disengaged the sulphur and arsenic, an eighth part, or even half a quintal, of quicklime may be added. With the above matters mix twelve pounds of charcoal-powder.

"Take a crucible, and cover the bottom and sides of its inner surface with a paste made of three parts of charcoal-dust and one part of clay beat together. In the hollow left in this paste put the above mixture; press it lightly down; cover it with pulverised glass; and put on the lid of the crucible.

"Place two such crucibles at the distance of about four fingers from the air-pipe, in such a manner that the air shall pass betwixt them at about the third part of the height from the bottom: fill the space betwixt the two crucibles with coals of a moderate size:

throw lighted coals upon them, that the fire may descend and make them red-hot from top to bottom: at first let the bellows blow softly, and afterwards strongly during an hour, or an hour and a quarter: then take away the crucible, and break it when cold. A regulus will be found in the bottom, and sometimes some small grains of iron in the scoria, which must be separated and weighed along with the regulus: then try the regulus whether it can be extended under the hammer, when hot and when cold.

Remarks. To disengage a metal from the earthy matters mixed with it by fire, we must change these matters into scoria or glass. This change may be effected by adding some substance capable of dissolving these matters; that is, of converting them into a scoria or glass, from which the metallic matters may, by their weight, separate and form a regulus at bottom. Fixed alkali, which is an ingredient of the black and of the white flux, is a powerful solvent of earths and stones: but the alkali does also dissolve iron, especially when this is in a calcined or earthy state; and this solution is so much more complete, as the fire is longer applied. Hence, in ordinary assays, where an alkaline salt is used, little or no regulus of iron is obtained. Now, glass acts upon and dissolves earths and stones; but not, or very little, iron: consequently glass is the best flux for such assays, and experience confirms this assertion. If the ore contains but little iron, we may also add to the glass some borax; but borax cannot be employed singly, because it very soon fuses, and separates from the ore before the metal is revived. Quicklime is added, not only to absorb the sulphur and arsenic remaining in the ore, but also because it dissolves and vitrifies the stony and earthy matters of iron ores, which are generally argillaceous. For which reason, in the large operations for smelting iron ore, quicklime, and even in certain cases gypsum, are commonly added to facilitate the fusion.

"The reduction of iron-ore, and even the fusion of iron, requires a violent and long-continued heat: therefore, in this operation, we must not employ an inflammable substance, as pitch, that is soon consumed, but charcoal pulverised, which in close vessels is not sensibly wasted. Too much charcoal must not be added, else it will prevent the action of the glass upon the earthy matter of the ore, and consequently the separation of the metallic part. Experiments have taught me, that one part of charcoal-dust to eight parts of ore was the best proportion.

"When iron is surrounded by charcoal, it is not decomposed or destroyed; hence the iron of the ore, which sinks into the hollow made of paste of charcoal-dust and clay, remains there unhurt. The clay is added in this paste to render it more compact, and to keep the fluid iron collected together.

"The air is directed betwixt the crucibles; because if it was thrown directly upon them, they would scarcely be able to resist the heat. The space betwixt the air-pipe and the crucibles ought to be constantly filled with charcoal, to prevent the cold air from touching the crucibles. Ductile and malleable iron is seldom obtained in this first operation. The sulphur and arsenic, and frequently also an earthy matter adhering to the iron, prevent these qualities."

SECT. VIII. *Ores of Mercury.*

§ 1. MERCURY is sometimes found pure, fluid, and in its proper metallic state, only mixed with earths and stones. Such are the ores of mercury found near Montpellier, in Tuscany, and in other places.

But the largest quantity of the mercury found in the earth is mineralised by sulphur, and consequently is in the form of cinnabar.

Mercury is never mineralised by arsenic. The richest mine of mercury is that of Almaden, in Spain.

Linnæus and Cronstedt mention a singular ore, in which the mercury is mineralised by sulphur and by copper. It is said to be of a blackish-grey colour, of a glassy texture, and brittle. When the mercury and sulphur are expelled by fire, the copper is discovered by giving an opaque red colour to glass of borax, which, by continuance and increase of heat, becomes green and transparent.

§ 2. Cramer directs, that *ores of mercury should be assayed* by the following processes:

P R O C E S S I.

To separate mercury out of an unfulphureous ore by distillation.

“TAKE a lump of the pulverised ore, one common pound, which must stand for one centner: put it into a glass retort perfectly clean, well loricated, or coated up to half the length of its neck: this must be very long, and turned backwards with such a declivity, that a glass recipient may be perpendicularly applied to it: but you must choose a retort small enough, that the belly of it may be filled hardly two-thirds with the ore: this retort must be placed so, that nothing of the fluid adherent to the neck of it may fall into the cavity of the belly, but that the whole may run forward into the recipient. Finally, have a small recipient full of cold water: let it be perpendicularly situated, and receive the neck of the retort in such manner that the extremity of it be hardly one half-inch immersed into the water.

“Let the retort be surrounded with hot burning coals placed at some distance in form of a circle, lest the vessel should burst by too sudden a heat: then by degrees bring the burning coals nearer and nearer, and at last surround the whole retort with them and with fresh charcoal, that it may grow slightly red-hot; this fire having been continued for an hour, let the retort cool of itself: then strike the neck of it gently, that the large drops which are always adherent to it may fall into the recipient: let the recipient be taken away, and the water separated from the mercury by filtration, and let the mercury be weighed. This operation may be more conveniently performed in a sand-bath; in which case the pot containing the sand must be middling red-hot, and the retort be able to touch the bottom of it immediately; nor is it then necessary that the retort be loricated.”

P R O C E S S II.

To revive mercury from a fulphureous cinnabar-ore.

“BEAT your ore extremely fine, and mix it exactly with an equal portion of iron-filings, not rusty;

proceed to distil it with the same apparatus as in the former process, but urge it with the strongest fire that can be made. Ores of Antimony.

“Cinnabar may be separated from stones by sublimation thus: Beat it to a fine powder, and put it into a small narrow glass or earthen cucurbit, the belly of which it must not fill more than one-third part: stop the orifice at top; this must be very narrow, to hinder the free action of the air. Put this small cucurbit in an earthen pot above two inches wide in diameter, and gather sand around this pot about as high as the pulverised ore rises in the cucurbit. Then put it upon burning coals in such manner that the bottom of the pot may be middling red-hot. Thus will your cinnabar ascend and form a solid ponderous ring, which must be got out by breaking the vessel.”

SECT. IX. *Ore of the Regulus of Antimony.*

NATIVE regulus of antimony was first observed by Mr Swab, in Sweden, in the mine of Salberg, and described by him in the memoirs of the Swedish Academy in 1749. Mr Wallerius mentions it in his Mineralogy.

Regulus of antimony is generally united with sulphur, with which it forms antimony, which ought to be considered as a true ore of the regulus of antimony.

Another ore of regulus of antimony is also known, of a red colour, in which the regulus is mineralised both by arsenic and by sulphur. This ore resembles some iron ores, and some kinds of blend. It is distinguished by its great fusibility, which is such, that it may be easily melted by the flame of a candle.

The *native regulus* of antimony, by Von Swab, is said by that author to have differed from the regulus of antimony obtained from ores, in these two properties, that it was capable of being easily amalgamated with mercury, and that its salts shot into crystals during the cooling.

Besides the ores of regulus of antimony enumerated above, this semimetal is also found in ores of other metallic substances, as in the *plumose silver-ore*, and in the *stibiated lead-ore*.

§ 2. The *ores of antimony may be assayed* by the following processes described by Mr Cramer.

P R O C E S S I

To obtain antimony from its ore.

“CHOOSE a melting crucible, or an earthen pot not glazed, that may contain some common pounds of the ore of antimony, broken into small bits. Bore at the bottom of the crucible some small holes, two lines in diameter. Let the bottom of the vessel be received by the orifice of a smaller one, upon which it must be put; and when the ore is put into it, let it be covered with a tile, and all the joints be stopped with lute.

“Put these vessels upon the pavement of a hearth, and put stones all around them at the distance of six inches. Fill this intermediate space with ashes, so high that the inferior pot be covered to the upper brim. Then put fresh and burning coals upon it, and with a pair of hand-bellows excite the fire, till the

Effaying the upper vessels grow red-hot: take off the fire a quarter of an hour after; and when the vessels are grown cold, open them. You will find that the melted antimony has run through the holes made at the bottom of the upper vessel into the inferior one, where it is collected."

P R O C E S S II.

To roast crude antimony, or its ore, with or without addition.

"CHOOSE an earthen, flat, low dish, not glazed; and if it cannot bear being made middling red-hot, cover it over with a coat of lute without. Spread it thinly over with crude antimony, or with its ore, beaten to a pretty coarse powder, not exceeding a few ounces at once. Put the dish upon a fire-pan, having a few burning coals in it: increase the fire till it begins to smoke a little. Meanwhile you must incessantly move the powder with a piece of new tobacco-pipe; for this causes the sulphur to evaporate the sooner. If you increase the fire a little too soon, the powder immediately gathers into large clots, or even begins to melt. When this happens, take it immediately off the fire before it melts entirely. Then pulverise it again, and finally make a gentle fire under it. Your black shining powder will assume an ash colour almost like that of earth, and become more refractory in the fire; wherefore you may then increase the fire till your powder grows middling red-hot, and let it last till it ceases to smoke. If you add to your crude antimony pulverised, half or an equal quantity of charcoal-dust, and perform the rest as above, the roasting will be done more conveniently: for it does not gather so easily into clots, and melts with much greater difficulty. When part of the sulphur is evaporated, add some fat to it at several times. Thus you will sooner finish the operation, and the remaining calx will not be burnt to excess. However, if it be thus exposed to too violent and long-lasting a fire, a great quantity of it evaporates; nor does it cease entirely to smoke in a great fire. And it will be enough, if, growing middling red-hot, it does no longer emit the unpleasant smell of the acid of sulphur."

P R O C E S S III.

To reduce a calx of antimony into a semimetallic regulus.

"Mix some calx of antimony with a quarter part of the black flux, and put it into the crucible. Cover the vessel with a tile; make the fire as quickly as the vessel can bear it, but not greater than is necessary to melt the flux. When the whole has been well in fusion for half a quarter of an hour (which may be tried with a tobacco-pipe, taking off the tile), pour it into the melting cone, which must be warm and done over with tallow. Then immediately strike the cone several times. You will find, when the cone is inverted, a regulus, above which is a saline scoria."

The methods of calcining antimony by means of nitre, are described under CHEMISTRY, n° 1252—1265; and those of obtaining a regulus of antimony without a previous calcination or roasting, by throwing a mixture of powdered antimony, tartar, and nitre, into a red-hot

crucible, and by fusing this mixture, and of obtaining a martial regulus of antimony, are described at the article REGULUS.

Ores of Bismuth.

SECT. X. Ores of Bismuth.

§ 1. BISMUTH is found *native*, resembling the regulus of bismuth.

An *ochre* of bismuth, of a whitish yellow colour, is mentioned by Cronstedt; and is different from the ore improperly called *flowers of bismuth*, which is a calx of cobalt.

Bismuth is mineralised, 1. By *sulphur*. This ore has the appearance of galena. 2. With *sulphurated iron*. Bismuth is found also in cobalts, and in some ores of silver.

§ 2. Ores of bismuth may be *effayed* by the following process.

"Bismuth ore may be melted with the same apparatus as was directed for the fusion of crude antimony out of its ore. Or you may beat your ore to a very fine powder, with the black flux, sandiver, and common salt, in a close vessel, like the ore of lead or of tin, and melt it in a middling fire, having a draught of air. But as this semimetal is destructible and volatile, you must as quick as possible apply it to that degree of fire which the flux requires to be melted; and so soon as it is well melted, the vessel must be taken out of the fire; and when it is grown quite cold and broken, you will find your regulus."

Mr Gellert directs that ores of bismuth should be effayed by fusing a quintal of pulverised ore with half a quintal of calcined borax and half a quintal of pulverised glass, in order to vitrify the adherent earths and stones which envelope the bismuth. But probably the heat requisite for this vitrification would volatilise part of the bismuth.

If the ore be of the kinds above described, mineralised by sulphur, or by sulphur and iron, a previous roasting would be expedient, which may be performed in the same manner as is directed for the roasting of antimony.

SECT. XI. Ores of the Regulus of Cobalt.

COBALT is a grey-coloured mineral, with more or less of a metallic appearance. Its grain is close; it is compact and heavy, and frequently covered with an efflorescence of peach-coloured flowers. Of this several kinds are known†. All the true cobalts contain the semimetal called *regulus* of cobalt, the calx of which becomes blue by vitrification. This regulus is mineralised in cobalt by sulphur, and especially by a large quantity of arsenic. Some cobalts also contain bismuth and silver.

† See Cobalts.

Authors have given the name of *cobalt* to many minerals, although they do not contain the semimetal above mentioned, but only because they externally resemble the ore of the regulus of cobalt. But these minerals can only be considered as false cobalts. They are distinguishable from true cobalt by trying whether they can yield the blue glass called *smalt*, and the sympathetic ink. The red efflorescence is also a mark by which true cobalt is distinguishable from the false:

Ores of
Cobalt.

false: but this efflorescence only happens when the ore has been exposed to a moist air.

The principal mines of cobalt are in Saxony, where they are dug for the sake of obtaining zaffre, azure-blue or smalt, and arsenic. Very fine cobalt is also found in the Pyrenean mountains. It has been likewise found in Cornwall and Scotland. And that it is in the eastern parts of Asia, appears from the blue colouring on old oriental porcelain: but probably the mines discovered in these countries are nearly exhausted, as considerable quantities of zaffre and smalt are exported from Europe to China.

Cobalt is heavier than most other ores, from the large quantity of arsenic it contains; and in this respect it resembles the ore of tin.

Besides the grey or ash-coloured cobalt above described, which is the most frequent, other cobalts are found of various colours and textures, mixed with various substances. Wallerius enumerates six species of cobalts. 1. The *ash-coloured ore*, which is regulus of cobalt mineralised by arsenic, consisting of shining leaden-coloured grains. Some ores of this kind are compact resembling steel, and others are of a loose texture and friable. 2. The *specular ore* is black, shining like a mirror, and laminated. This species is very rare; and is supposed by Wallerius to be a foliated spar, or selenites mixed with cobalt. 3. The *vitreous or slag-like ore*, is of a bluish, shining colour, compact, or spongy. 4. *Crystallized ore*, is a grey, deep-coloured cobalt, consisting of clusters of cubical, pyramidal, prismatic crystals. 5. *Flowers of cobalt*, red, yellow, or violet. These flowers seem to be formed from some of the above-described compact ores, decomposed by exposure to moist air. This decomposition is similar to that which happens to ferruginous and cupreous pyrites. 6. The *earthy cobalt* is of a greenish white, or of a yellow colour, and of a soft and friable texture. This species seems to be an ochre of cobalt; and is formed perhaps from the flowers of cobalt further decomposed, in the same manner as a martial ochre is formed from the saline efflorescence of decomposing pyrites, when this efflorescence is further decomposed by exposure to moist air; by which the vitriolic acid contained in it is expelled, and the efflorescence is changed from a saline state to that of an ochre or calx.

Besides these proper ores, cobalt is also found in a blue clay along with native silver, in ores of bismuth, and in the mineral called *kupfernickel*. See NICKEL.

The *essay* of cobalt is described at the article REGULUS of Cobalt.

SECT. XII. Ores of Zinc.

§ 1. THE proper ore of zinc is a substance which has rather an earthy or stony than metallic appearance, and is called *calamy*, *calamine*, or *lapis calaminaris*. This stone, although metallic, is but moderately heavy, and has not the brilliancy of most other ores. Its colour is yellow, and like that of rust. It is also less dense than other metallic minerals. It seems to be an ore naturally decomposed. The calamine is not worked directly to obtain zinc from it, because this

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would only succeed in close vessels, and consequently with small quantities, according to Mr Margraaf's process. But it is successfully employed for the conversion of copper into brass by cementation, by which the existence of zinc in that stone is sufficiently proved.

Mr Wallerius enumerates also amongst the ores of zinc a very compounded mineral, consisting of zinc, sulphur, iron, and arsenic. This mineral, called *blend*, resembles externally the ore of lead, and hence has been called *false galena*. These blends have different forms and colours; but are chiefly red, like the red ore of antimony.

Zinc is obtained from certain minerals in the East Indies, of which we know little.

Calcsiform ores of zinc, according to Cronstedt, are pure or mixed. The pure are indurated, and sometimes crystallised, resembling lead-spar. The mixed ore contains also some calx of iron. This is *calamine*. It is whitish, yellowish, reddish, or brown.

Zinc is *mineralised*, 1. By *sulphurated iron*. Ore of zinc. Wallerius says, lead is sometimes contained in this ore. It is white, blue, or brown. 2. By *sulphur, arsenic, and iron*. *Blend*, or *pseudo-galena*, or *false-galena*, or *black-jack*. These are of various colours, white, yellowish, brown, reddish, greenish, black. They consist of scales, or are tessellated. Mr Cronstedt thinks, that in blends the zinc is mineralised in the state of a calx, and in the ore of zinc in its metallic state.

§ 2. Although the minerals above enumerated have been known, from their property of converting copper into brass, to be ores of zinc, yet the method of essaying them so as to obtain the contained zinc was not known, or at least not published, before Mr Margraaf's Memoir of the Berlin Academy for the year 1746, upon that subject. That very able chemist has shown, that zinc may be obtained from its ores, from the flowers, or from any other calx of zinc, by treating these with charcoal-dust, in close vessels, to prevent the combustion of the zinc, which happens immediately upon its reduction when exposed to air. For this purpose, he put a quantity of finely powdered calamine, or roasted blend, or other calx of zinc, well mixed with an eighth part of charcoal-dust, into a strong, luted earthen retort, to which he fitted a receiver. Having placed his retort in a furnace and raised the fire, he applied a violent heat during two hours. When the vessels were cold and broken, he found the zinc in its metallic form adhering to the neck of the retort.

The chief difficulty in this operation is to get an earthen retort sufficiently compact to retain the vapour of the zinc (for it easily pervades the Hessian crucibles, Stourbridge melting-pots, and similar vessels, as may be seen from the quantity of flowers which appear upon their outer surface, when zinc or its calxes and any inflammable matter have been exposed to heat within these vessels), and at the same time sufficiently strong to resist the violent fire which Mr Margraaf requires.

A pretty exact essay of an ore of zinc may be made in the following manner:

Mix a quantity of pulverised roasted ore or calx of zinc with

Ores of
Zinc.

Ores of Arsenic. with an eighth part of charcoal-dust. Put this mixture into a crucible capable of containing thrice the quantity. Diffuse equally amongst this mixture a quantity of small grains or thin plates of copper equal to that of the calamine or ore employed, and upon the whole lay another equal quantity of grains or plates of copper; and lastly, cover this latter portion of copper with charcoal-dust. Lute a lid upon the crucible, and apply a red heat during an hour or two. The copper or part of it will unite with the vapour of the zinc, and be thereby converted into brass. By comparing the weight of all the metal after the operation with the weight of the copper employed, the weight acquired, and consequently the quantity of zinc united with the copper, will be known. The copper which has not been converted into brass, or more copper with fresh charcoal-dust, may be again added in the same manner to the remaining ore, and the operation repeated with a heat somewhat more intense, that any zinc remaining in the ore may be thus extracted. A curious circumstance is, that a much greater heat is required to obtain zinc from its ore by distillation, than in the operation now described of making brass; in which the separation of the zinc from its ore seems to be facilitated by its disposition to unite with copper.

SECT. XIII. *Ores of Arsenic.*

§ I. THE minerals which contain the largest quantity of arsenic are cobalts and white pyrites; although it is also contained in other ores, it being one of the mineralising substances. But as cobalt must be roasted to obtain the sulphur it contains, the arsenic also which rises during this torrefaction is collected, as we shall see in Part III. (SMELTING OF ORES), and the particular articles of each of the metallic substances mentioned in this article.

I. Regulus of arsenic is found native. It is of a leaden colour; it burns with a small flame; and is dissipated, leaving generally a very small quantity of calx of bismuth, or of calx of cobalt, and a very little silver. When it is of a solid and testaceous texture, it has been improperly called *testaceous cobalt*, in German *scherbencobalt*. II. Calx of arsenic is found in form of powder; native flowers of arsenic, or of indurated semitransparent crystals; native crystalline arsenic. III. Calx of arsenic is mixed, 1. With sulphur; when yellow, it is called *orpiment*; when red, it is called *native realgar*: the difference of colour depends on the proportion of the two component parts. 2. With

calx of tin; tin-grains. 3. With sulphur and silver, in the red silver ore. 4. With calx of lead, in the lead-spar. 5. With calx of cobalt, in the efflorescence of cobalt. IV. Arsenic is mineralised, 1. With sulphurated iron; arsenical pyrites. 2. With iron only; white pyrites, or mispickle. 3. With cobalt, in almost all cobalt-ores. 4. With silver. 5. With copper. 6. With antimony.

§ 2. Arsenic may be separated from its ore or earthy matter with which it happens to be mixed, by sublimation, according to the following process by Mr Cramer.

“Do every thing as was said about mercury, or sulphur; but let the vessel which is put into the fire with the ore in it be of earth or stone, and the recipient be of glass, and of a middling capacity. Nor is it necessary that this should be filled with water, so it be but well luted. The fire must likewise be stronger, and continued longer than for the extracting of sulphur. Nevertheless, every kind of arsenic cannot be extracted in a confined fire: for it adheres to the matrix more strongly than sulphur and mercury. You will find in the part of the vessel which is more remote from the fire, pulverulent and subtle flowers of arsenic; but there will adhere to the posterior of the neck of the retort small solid masses, shining like small crystals, transparent, sometimes gathered into a solid sublimate, and perfectly white, if the ore of the arsenic was perfectly pure; which nevertheless happens very seldom. The flowers are most commonly thin, and of a grey colour: which proceeds from the phlogiston mixed with the mass. They are often of a citron or of a golden colour, which is a sign that there is in the mixture some mineral sulphur; and if the sublimate be red or yellow, it is a sign of much sulphur.

“As all the arsenic contained in the ore is not expelled in close vessels, you must weigh the residuum; then roast it in a crucible till it smokes no longer, or rather in an earthen flat vessel not glazed, and in a strong fire to be stirred now and then with a poker, and then weigh it when grown cold: you will be able thus to know how much arsenic remained in the close vessel, unless the ore contain bismuth.”

If the arsenic be sulphurated, it may be purified by triturating it with mercury or with fixed alkali, and by subliming the arsenic from the remaining sulphurated mercury or alkali. The method of obtaining a regulus of arsenic is described at the article *REGULUS of Arsenic*.

P A R T III.

S M E L T I N G O F O R E S.

HAVING shown the nature of the principal metallic minerals, and the substances of which they are composed; and also explained the processes by which an exact analysis of these compound minerals may be made, and the nature and quantity of the contained metals may be known; in order to complete what relates to this important subject, we shall describe in this Part the principal operations by which metals, &c.

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are obtained “in the great,” as it is called, or for commercial purposes. What we shall say upon this subject will chiefly be extracted from a *Treatise on the Smelting of Ores*, by Schlutter, translated from the German into French by M. Hellot; because this, of all the modern works upon that subject, appears to be the most exact. We shall first describe the operations upon pyritous matters for the extraction of sul-

3 M

phur

Sulphur
Works.

phur, &c. and afterwards the operations by which metallic substances are extracted from *ores* properly so called.

SECT. I. *Extraction of Sulphur from Pyrites and other Minerals.*

IN order to obtain sulphur from pyrites, this mineral ought to be exposed to a heat sufficient to sublime the sulphur, or to make it distil in vessels, which must be close, to prevent its burning.

Sulphur is extracted from pyrites at a work at Schwartzember, in Saxony, in the high country of the mines; and in Bohemia at a place called *Alten-Sattel*.

The furnaces employed for this operation are oblong, like vaulted galleries; and in the vaulted roofs are made several openings. These are called *furnaces for extracting sulphur*.

In these furnaces are placed earthen-ware tubes, filled with pyrites broken into pieces of the size of small nuts. Each of these tubes contains about 50 pounds of pyrites. They are placed in the furnace almost horizontally, and have scarcely more than an inch of descent. The ends, which come out of the furnace five or six inches, become gradually narrower. Within each tube is fixed a piece of baked earth, in form of a star, at the place where it begins to become narrower, in order to prevent the pyrites from falling out, or choaking the mouth of the tube. To each tube is fitted a receiver, covered with a leaden pipe, pierced with a small hole to give air to the sulphur. The other end of the tube is exactly closed. A moderate fire is made with wood, and in eight hours the sulphur of the pyrites is found to have passed into the receivers.

The residuum of the pyrites, after the distillation, is drawn out at the large end, and fresh pyrites is put in its place. From this residuum, which is called *burnings of sulphur*, vitriol is extracted.

The 11 tubes, into which were put, at three several distillations, in all nine quintals, or 900 pounds of pyrites, yield from 100 to 150 pounds of crude sulphur, which is so impure as to require to be purified by a second distillation.

This purification of crude sulphur is also done in a furnace in form of a gallery, in which five iron cucurbits are arranged on each side. These cucurbits are placed in a sloping direction, and contain about eight quintals and a half of crude sulphur. To them are luted earthen tubes, so disposed as to answer the purpose of capitals. The nose of each of these tubes is inserted into an earthen pot called the *fore-runner*. This pot has three openings; namely that which receives the nose of the tube; a second smaller hole, which is left open to give air; and a third in its lower part, which is stopped with a wooden peg.

When the preparations are made, a fire is lighted about seven o'clock in the evening, and is a little abated as soon as the sulphur begins to distil. At three o'clock in the morning, the wooden pegs which stop the lower holes of the fore-runners are for the first time drawn out, and the sulphur flows out of each of them into an earthen pot with two handles, placed

below for its reception. In this distillation the fire must be moderately and prudently conducted; otherwise less sulphur would be obtained, and it also would be of a grey colour, and not of the fine yellow which it ought to have when pure. The ordinary loss in the purification of eight quintals of crude sulphur is, at most, one quintal.

When all the sulphur has flowed out, and has cooled a little in the earthen pots, it is cast into moulds made of beech-tree, which have been previously dipt in water and set to drain. As soon as the sulphur is cooled in the moulds, they are opened, and the cylinders of sulphur are taken out and put up in casks. These are called *roll-brimstone*.

As sulphur is not only in pyrites, but also in most metallic minerals, it is evident that it might be obtained by works in the great from the different ores which contain much of it, and from which it must be separated previously to their fusion: but as sulphur is of little value, the trouble of collecting it from ores is seldom taken. Smelters are generally satisfied with freeing their ores from it, by exposing them to a fire sufficient to expel it. This operation is called *torrefaction*, or *roasting of ores*.

There are, however, ores which contain so much sulphur, that part of it is actually collected in the ordinary operation of roasting, without much trouble for that purpose. Such is the ore of Ramelsberg in the country of Hartz.

This ore, which is of lead, containing silver, is partly very pure, and partly mixed with cupreous pyrites and silver; hence it is necessary to roast it.

The roasting is performed by laying alternate strata of ore and wood upon each other in an open field, taking care to diminish the size of the strata as they rise higher; so that the whole mass shall be a quadrangular pyramid truncated above, whose base is about 31 feet square. Below, some passages are left open, to give free entrance to the air; and the sides and top of the pyramid are covered over with small ore, to concentrate the heat and make it last longer. In the centre of this pyramid there is a channel which descends vertically from the top to the base. When all is properly arranged, ladlefuls of red-hot scoria from the smelting furnace are thrown down the channel, by which means the shrubs and wood placed below for that purpose are kindled, and the fire is from them communicated to all the wood of the pile, which continues burning till the third day. At that time the sulphur of the mineral becomes capable of burning spontaneously, and of continuing the fire after the wood is consumed.

When this roasting has been continued 15 days, the mineral becomes greasy; that is, it is covered over with a kind of varnish: 20 or 25 holes or hollows are then made in the upper-part of the pile in which the sulphur is collected. From these cavities the sulphur is taken out thrice every day, and thrown into water. This sulphur is not pure, but crude; and is therefore sent to the manufacturers of sulphur, to be purified in the manner above related.

As this ore of Ramelsberg is very sulphureous, the first roasting, which we are now describing, lasts three months; and during this time, if much rain has not fallen, or if the operation has not failed by the pile

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falling down or cracking, by which the air has so much free access, that the sulphur is burnt and consumed, from 10 to 20 quintals of crude sulphur are by this method collected.

The sulphur of this ore, like that of most others, was formerly neglected, till, in the year 1570, a person employed in the mines called *Christopher Sauder*, discovered the method of collecting it, nearly as it is done at present.

Metallic minerals are not the only substances from which sulphur is extracted. This matter is diffused in the earth in such quantities, that the metals cannot absorb it all. Some sulphur is found quite pure, and in different forms, principally in the neighbourhood of volcanoes, in caverns, and in mineral waters. Such are the opaque kind called *virgin-sulphur*; the transparent kind called *sulphur of Quito*; and the native flowers of sulphur, as those of the waters of Aix-la-Chapelle. It is also found mixed with different earths. Here we may observe, that all those kinds of sulphur which are not mineralised by metallic substances, are found near volcanoes, or hot mineral waters, and consequently in places where nature seems to have formed great subterranean laboratories, in which sulphureous minerals may be analysed and decomposed, and the sulphur separated, in the manner in which it is done in small in our works and laboratories. However that be, certainly one of the best and most famous sulphur-mines in the world is that called *Solfatara*. The Abbé Nollet has published, in the *Memoirs of the Academy*, some interesting observations upon this subject, which we shall here abridge.

Near Puzzoli, in Italy, is that great and famous mine of sulphur and alum called at present *Solfatara*. It is a small oval plain, the greatest diameter of which is about 400 yards, raised about 300 yards above the level of the sea. It is surrounded by high hills and great rocks, which fall to pieces, and whose fragments form very steep banks. Almost all the ground is bare and white, like marle; and is every-where sensibly warmer than the atmosphere in the greatest heat of summer, so that the feet of persons walking there are burnt through their shoes. It is impossible not to observe the sulphur there; for every-where may be perceived by the smell a sulphureous vapour, which rises to a considerable height, and gives reason to believe that there is a subterraneous fire below, from which that vapour proceeds.

Near the middle of this field there is a kind of basin three or four feet lower than the rest of the plain, in which a sound may be perceived when a person walks on it, as if there were under his feet some great cavity, the roof of which was very thin. After that, the lake Agnano is perceived, whose waters seem to boil. These waters are indeed hot, but not so hot as boiling water. This kind of ebullition proceeds from vapours which rise from the bottom of the lake, which being set in motion by the action of subterranean fires, have force enough to raise all that mass of water. Near this lake there are pits, not very deep, from which sulphureous vapours are exhaled. Persons who have the itch come to these pits, and receive the vapours in order to be cured. Finally, there are some deeper excavations, whence a soft stone is pro-

cured which yields sulphur. From these cavities vapours exhale, and issue out with noise, and which are nothing else than sulphur subliming through the crevices. This sulphur adheres to the sides of the rocks, where it forms enormous masses: in calm weather, the vapours may be evidently seen to rise 25 or 30 feet from the surface of the earth.

These vapours, attaching themselves to the sides of rocks, form enormous groups of sulphur, which sometimes fall down by their own weight, and render these places of dangerous access.

In entering the *Solfatara*, there are warehouses and buildings erected for the refining of sulphur.

Under a great shed, or hangar, supported by a wall behind, and open on the other three sides, the sulphur is procured by distillation from the soft stones we mentioned above. These stones are dug from under ground; and those which lie on the surface of the earth are neglected. These last are, however, covered with a sulphur ready formed, and of a yellow colour: but the workmen say they have lost their strength, and that the sulphur obtained from them is not of so good a quality as the sulphur obtained from the stones which are dug out of the ground.

These last mentioned are broken into lumps, and put into pots of earthen ware, containing each about 20 pints Paris measure. The mouths of these pots are as wide as their bottoms; but their bellies, or middle parts, are wider. They are covered with a lid of the same earth, well luted, and are arranged in two parallel lines along two brick walls, which form the two sides of a furnace. The pots are placed within these walls; so that the centre of each pot is in the centre of the thickness of the wall, and that one end of the pots overhangs the wall within, while the other end overhangs the wall without. In each furnace ten of these pots are placed; that is, five in each of the two walls which form the two sides of the furnace." Between these walls there is a space of 15 or 18 inches; which space is covered by a vault resting on the two walls. The whole forms a furnace seven feet long, two feet and a half high; open at one end, and shut at the other, excepting a small chimney through which the smoke passes.

Each of these pots has a mouth in its upper part without the furnace, in order to admit a tube of 18 lines in diameter and a foot in length, which communicates with another pot of the same size placed without the building, and pierced with a round hole in its base of 15 or 18 lines diameter. Lastly, to each of these last-mentioned pots there is a wooden tub placed below, in a bench made for that purpose.

Four or five of these furnaces are built under one hangar, or shed. Fires are kindled in each of them at the same time; and they are thrown down after each distillation, either that the pots may be renewed, or that the residuums may be more easily taken out.

The fire being kindled in the furnace, heats the first pots containing the sulphureous stones. The sulphur rises in fumes into the upper part of the pot, whence it passes through the pipe of communication into the external vessel. There the vapours are condensed, become liquid, and flow through the hole below into the tub, from which the sulphur is easily turned out, because the form of the vessel is that of a truncated cone

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Extraction of VITRIOL from pyrites. See CHEMISTRY.

Extraction of ALUM from pyritous substances and from aluminous earths. See CHEMISTRY.

SECT. II. Smelting of Ores in general.

§ 1. As ores consist of metallic matters combined with sulphur and arsenic, and are besides intermixed with earthy and stony substances of all kinds, the intention of all the operations upon these compound bodies is to separate these different substances from each other. This is effected by several operations founded on the known properties of those substances. We now proceed to give a general idea of these several operations.

First of all, the ore is to be separated from the earths and stones accidentally adherent to it; and when these foreign substances are in large masses, and are not very intimately mixed in small particles with the ore, this separation may be accomplished by mechanical means. This ought always to be the first operation, unless the adherent substance be capable of serving as a flux to the ore. If the unmetallic earths be intimately mixed with the ore, this must necessarily be broken and divided into small particles. This operation is performed by a machine which moves pestles, called *bocords* or *stampers*. After this operation, when the parts of the mineral are specifically heavier than those of the unmetallic earth or stone, these latter may be separated from the ore by washing in canals through which water flows. With regard to this washing of ores, it is necessary to observe, that it cannot succeed but when the ore is sensibly heavier than the foreign matters. But the contrary happens frequently, as well because quartz and spar are naturally very ponderous, as because the metallic matter is proportionally so much lighter as it is combined with more sulphur.

When an ore happens to be of this kind, it is necessary to begin by roasting it, in order to deprive it of the greatest part of its sulphur.

It happens frequently that the pyritous matters accompanying the ore are so hard that they can scarcely be pounded. In this case it is necessary to roast it entirely, or partly, and to throw it red-hot into cold-water; by which the stones are split, and rendered much more capable of being pulverised.

Thus it happens very frequently, that roasting is the first operation to which an ore is exposed.

When the substance of the ore is very fusible, this first operation may be dispensed with, and the matter may be immediately fused without any previous roasting, or at least with a very slight one. For, to effect this fusion, it is necessary that it retain a great quantity of its sulphur, which, with the other fluxes added, serves to destroy or convert into scoria a considerable part of the stony matter of the mineral, and to reduce the rest into a brittle substance, which is called the *matt*

of lead or of copper, or other metal contained in the ore. This matt is therefore an intermediate matter betwixt the mineral and the metal; for the metal is there concentrated, and mixed with less useless matter than it was in the ore. But as this matt is always sulphureous, the metal which it contains cannot have its metallic properties. Therefore it must be roasted several times to evaporate the sulphur, before it is remelted, when the pure metal is required. This fusion of an ore not roasted, or but slightly roasted, is called *crude fusion*.

We may here observe upon the subject of washing and roasting of ores, that as arsenic is heavier than sulphur, and has nearly the weight of metals, the ores in which it prevails are generally very heavy, and consequently are susceptible of being washed, which is a great advantage. But on the other side, as arsenic is capable of volatilising, scorifying, and destroying many metals, these ores have disadvantages in the roasting and fusion, in both which considerable loss is caused by the arsenic. Some ores contain, besides arsenic, other volatile semimetals, such as antimony and zinc. These are almost untractable, and are therefore neglected. They are called *minera rapaces*, "rapacious ores."

When the metal has been freed as much as is possible from foreign matters by these preliminary operations, it is to be completely purified by fusions more or less frequently repeated; in which proper additions are made, either to absorb the rest of the sulphur and arsenic, or to complete the vitrification or scorification of the unmetallic stones and earth.

Lastly, as ores frequently contain several different metals, these are to be separated from each other by processes suited to the properties of these metals, of which we shall speak more particularly as we proceed in our examination of the ores of each metal.

§ 2. To facilitate the extraction of metallic substances from the ores and minerals containing them, some operations previous to the fusion or smelting of these ores and minerals are generally necessary. These operations consist of, 1. The *separation* of the ores and metallic matters from the adhering unmetallic earths and stones, by hammers and other mechanical instruments, and by washing with water. 2. Their *division* or reduction into smaller parts by contusion and trituration, that by another washing with water they may be more perfectly cleansed from extraneous matters, and rendered fitter for the subsequent operations, calcination or roasting, and fusion. 3. *Roasting* or *calcination*; the uses of which operation are, to expel the volatile, useless, or noxious substances, as water, vitriolic acid, sulphur, and arsenic; to render the ore more friable, and fitter for the subsequent contusion and fusion; and, lastly, to calcine and destroy the viler metals, for instance the iron of copper-ores, by means of the fire, and of the sulphur and arsenic. Stones, as quartz and flints, containing metallic veins or particles, are frequently made red-hot, and then extinguished in cold water, that they may be rendered sufficiently friable and pulverable, to allow the separation of the metallic particles.

Roasting is unnecessary for native metals; for some of the richer gold and silver ores; for some lead-ores, the

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Roasting of the sulphur of which may be separated during the fusion; and for many calciform ores, as these do not generally contain any sulphur and arsenic.

In the roasting of ores, the following attentions must be given, 1. To reduce the mineral previously into small lumps, that the surface may be increased; but they must not be so small, nor placed so compactly, as to prevent the passage of the air and flame. 2. The larger pieces must be placed at the bottom of the pile, where the greatest heat is. 3. The heat must be gradually applied, that the sulphur may not be melted, which would greatly retard its expulsion; and that the spars, fluors, and stones, intermixed with the ore, may not crack, fly, and be dispersed. 4. The ores not thoroughly roasted by one operation must be exposed to a second. 5. The fire may be increased towards the end, that the noxious matters more strongly adhering may be expelled. 6. Fuel which yields much flame, as wood and fossil coals free from sulphur, is said to be preferable to charcoal or coaks. Sometimes cold water is thrown on the calcined ore at the end of the operation, while the ore is yet hot, to render it more friable.

No general rule can be given concerning the duration or degree of the fire, these being very various according to the difference of the ores. A roasting during a few hours or days is sufficient for many ores; while some, such as the ore of Rammelsberg, require that it should be continued during several months.

Schlutter enumerates five methods of roasting ores.

1. By constructing a pile of ores and fuel placed in alternate strata, in the open air, without any furnace.
2. By confining such a pile within walls, but without a roof.
3. By placing the pile under a roof, without lateral walls.
4. By placing the pile in a furnace consisting of walls and a roof.
5. By roasting the ore in a reverberatory furnace, in which it must be continually stirred with an iron rod.

Several kinds of fusions of ores may be distinguished. 1. When a sulphureous ore is mixed with much earthy matter, from which it cannot be easily separated by mechanical operations, it is frequently melted, in order to disengage it from these earthy matters, and to concentrate its metallic contents. By this fusion, some of the sulphur is dissipated, and the ore is reduced to a state intermediate betwixt that of ore and of metal. It is then called a *matt* (*lapis sulphureo-metallicus*); and is to be afterwards treated like a pure ore by the second kind of fusion, which is properly the smelting, or extraction of the metal by fusion. 2. By this fusion or smelting, the metal is extracted from the ore previously prepared by the above operations, if these be necessary. The ores of some very fusible metals, as of bismuth, may be smelted by applying a heat sufficient only to melt the metals, which are thereby separated from the adhering extraneous matters. This separation of metals by fusion, without the vitrification of extraneous matters, may be called *eliquation*. Generally, a complete fusion of the ore and vitrification of the earthy matters are necessary for the perfect separation of the contained metals. By this method, metals are obtained from their ores, sometimes pure, and sometimes mixed with other metallic substances, from which they must be afterwards separated; as we

shall see when we treat of the extraction of particular metals. To procure this separation of metals from ores, these must be so thinly liquefied, that the small metallic particles may disengage themselves from the scoria; but it must not be so thin as to allow the metal to precipitate before it be perfectly disengaged from any adhering extraneous matter, or to pervade and destroy the containing vessels and furnace. Some ores are sufficiently fusible; but others require certain additions called *fluxes*, to promote their fusion and the vitrification of their unmetallic parts; and also to render the scoria sufficiently thin to allow the separation of the metallic particles.

Different fluxes are suitable to different ores, according to the quality of the ore, and of the matrix, or stone adherent to it.

The matrixes of two different ores of the same metal frequently serve as fluxes to each other; as, for instance, an argillaceous matrix with one that is calcareous; these two earths being disposed to vitrification when mixed, though each of them is singly unfusible. For this reason, two or more different ores to be smelted are frequently mixed together.

The ores also of different metals require different fluxes. Thus calcareous earth is found to be best suited to iron-ores, and spars and scoria to fusible ores of copper.

The fluxes most frequently employed in the smelting of ores are, calcareous earths, fluors or vitreous spars, quartz, and sand, fusible stones, as slates, basaltes, the several kinds of scoria, and pyrites.

Calcareous earth is used to facilitate the fusion of ores of iron, and of some of the poorer ores of copper, and, in general, of ores mixed with argillaceous earths, or with felspar. This earth has been sometimes added with a view of separating the sulphur, to which it very readily unites: but by this union the sulphur is detained, and a hepar is formed, which readily dissolves iron and other metals, and so firmly adheres to them, that they cannot be separated without more difficulty than they could from the original ore. This addition is therefore not to be made till the sulphur be previously well expelled.

Fluors or fusible spars facilitate the fusion of most metallic minerals, and also of calcareous and argillaceous earths, of steatites, asbestos, and some other unfusible stones, but not of silicious earths without a mixture of calcareous earth.

Quartz is sometimes added in the fusion of ferruginous copper ores, the use of which is said chiefly to be, to enable the ore to receive a greater heat, and to give a more perfect vitrification to the ferruginous scoria.

The *fusible stones*, as *slates*, *basaltes*, are so tenacious and thick when fused, that they cannot be considered properly as fluxes, but as matters added to lessen the too great liquidity of some very fusible minerals.

The *scoria* obtained in the fusion of an ore is frequently useful to facilitate the fusion of an ore of the same metal, and sometimes even ores of other metals.

Sulphurated pyrites greatly promote the fusibility of the scoria of metals, from the sulphur it contains. It is chiefly added to difficultly-fusible copper-ores, to form the sulphureous compounds called *matts*, that the

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ores thus brought into fusion may be separated from the adhering earthy matters, and that the ferruginous matter contained in them may be destroyed, during the subsequent calcination and fusion, by means of the sulphur.

As in the ores called *calciform*, the metallic matter exists in a calcined state; and as calcination reduces the metals of mineralised ores (excepting the perfect metals) to that state also; therefore all calciform and calcined ores require the addition of some inflammable substance, to reduce them to a metallic state. In great works, the charcoal or other fuel used to maintain the fire produces also this effect.

Metals are sometimes added in the fusion of ores of other more valuable metals, to absorb from these sulphur or arsenic. Thus iron is added to sulphurated, cupreous, and silver ores. Metals are also added in the fusion of ores of other more valuable metals, to unite with and collect the small particles of these dispersed through much earthy matter, and thus to assist their precipitation. With these intentions lead is frequently added to ores and minerals containing gold, silver, or copper.

Ores of metals are also sometimes added to assist the precipitation of more valuable metals. Thus antimony is frequently added to assist the precipitation of gold intermixed with other metallic matters. Thus far of smelting of ores in general.

SECT. III. Smelting of Ores of Silver.

§ 1. As silver, even in its proper ores, is always allayed with some other metals from which it is intended to be separated after the silver-ore has been well roasted, it must be mixed with a greater or less quantity of lead previous to its fusion.

Lead has the same effect in fusion of gold and silver as mercury has upon these metals by its natural fluidity; that is to say, it unites with them, and separates them from unmetallic matters, which, being lighter, rise always to the surface. But lead has the further advantage of procuring, by its own vitrification, that of all metallic substances, excepting gold and silver. Hence it follows, that when gold and silver are obtained by means of mercury, they still remain allayed with other metallic substances; whereas when they are obtained by fusion and scorification with lead, they are then pure, and not allayed with any metals but with each other.

In proportion as the lead, which has been united to the gold and silver of the ore, is scorified by the action of the fire, and promotes the scorification of the other metallic matters, it separates the perfect metals, and carries with it all the others to the surface. There it meets the unmetallic substances, which it likewise vitrifies, and which it changes into a perfect scoria, fluid, and such as a scoria ought to be to admit all the perfect metal contained in it to precipitate.

When all heterogeneous matters have been thus disengaged by scorification with lead, the perfect metals, to which some lead still remains united, are to be further purified by the ordinary operation of the cupel.

The common rule for the fusion and scorification of silver-ore with lead, is to add to the ore a quantity of

lead so much greater as there is more matter to be scorified, and as these matters are more refractory and of more difficult fusion. Silver ores, or those treated as such, are often rendered refractory by ferruginous earths, pyritous matters, or cobalts, containing always a considerable quantity of an earth which is unmetallic, very subtil, and very refractory, and which renders a considerable augmentation of the quantity of lead necessary.

The quantity of lead which is commonly added to fusible silver ores, that do not contain lead, is eight times the quantity of the ore. But when the ore is refractory, it is necessary to add twelve times the quantity of lead, and even more; also glass of lead, and fluxes, such as the white and black fluxes; to which however borax and powder of charcoal are preferable, on account of the liver of sulphur formed by these alkaline fluxes.

It is necessary to observe, that saline fluxes are only used in small operations, on account of their dearth. To these are substituted, in the great operations, of which we now treat, sandiver, fusible scoria, and other matters of little value.

The greatest part of silver now employed in commerce is not obtained from the proper ores of silver, which are very scarce; but from lead, and even copper ores, which are more or less rich in silver. To give an idea of the manner of treating these kinds of ores, from which silver is extracted in the great works, we shall briefly describe here, after Schlutter, the smelting of the ore of Ramelsberg, which contains, as we have already said, several different kinds of metals, but particularly lead and silver.

When this mineral has been disengaged from its sulphur as much as possible by three very long roastings, it is melted, in the Lower Hartz in Saxony, in a particular kind of furnace, called a *furnace for smelting upon a hollow or casse*. The masonry of this furnace is composed of large thick slates, capable of sustaining great heat, and cemented together by clay. The interior part of the furnace is three feet and a half long, and two feet broad at the back part, and one foot only in the front. Its height is nine feet eight inches. It has a foundation of masonry in the ground; and in this foundation channels are made for the evaporation of the moisture. These channels are covered over with stones called *covering stones*. The hollow or casse, which is made above these, is formed of bricks, upon which are placed, first, a bed of clay; then a bed of small ore and sifted vitriols; and, lastly, a bed of charcoal powder beat down, called *light brasque*. The anterior wall of the furnace is thinner than the others, and is called the *chemise*. The back wall, which is pierced to give passage to the pipes of two large wooden bellows, is called the *middle wall*. When the furnace is thus prepared, charcoal is thrown into the hollow, or casse; which being kindled, the fire is to be continued during three hours, before the matters to be fused are added. Then these matters are thrown in, which are not the pure ore, but a mixture of several substances, all of which are somewhat profitable. The quantity of these matters is sufficient for one day's work; that is, for a fusion of eighteen hours; and it consists of, 1. Twelve schorbens or measures of well roasted Rammelsberg ore (the schorben is a measure whose contents are

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two feet five inches long, one foot seven inches broad, and a little more than a foot deep: it is equal to 32 quintals of that country, Cologne weight, at 123 pounds each quintal). 2. Six measures of scoria produced by the smelting of the ore of Upper Hartz, which is refractory, and what workmen call *cold*. 3. Two measures of knobben, which is an impure scoria containing some lead and silver, which has been formerly thrown away as useless, and is now collected by women and children. Besides these, other matters are added, containing lead and silver, as the tests employed in refining, the dross of lead, impure litharge, and any rubbish containing metal, which was left in the furnace after the foregoing fusion. All these matters being mixed together, are thrown into the furnace: and to each measure of this mixture a measure of charcoal is added. The fusion is then begun by help of bellows; and as it proceeds, the lead falls through the light brasque or charcoal-bed into the hollow, or casse, where it is preserved from burning under the powder of charcoal. The scoria, on the other hand, being lighter and less fluid, is skimmed off from time to time by means of ladles, that it may not prevent the rest of the lead from falling down into the hollow. Thus, while the fusion lasts, fresh matters and fresh charcoal are alternately added, till the whole quantity intended for one fusion, or, as they call it, one *day*, be thrown in.

There are several essential things to be remarked in this operation, which is very well contrived. First, The mixture of matters from which a little lead and silver is procured, which would otherwise be lost; and which have also this advantage, that they retard the fusion of the Ramelsberg ore, which, however well roasted it has been, retains always enough of the sulphur and iron of the pyrites mixed with it, to render it too fusible or too fluid; so that without the addition of those matters nothing would be obtained but a matt. It is even necessary, notwithstanding these additions, not to hasten the fusion too much, but to give time for the ore to mix with other matters, else it would melt and flow of itself before the rest. Secondly, The fusion of the ore through charcoal, which is practised in most smelting-houses, and for almost all ores, is an excellent method, the principal advantage of which is the saving of fuel. The action of the burning charcoal directed immediately upon the mineral, at the same time that it melts it more readily and efficaciously, also supplies it with the phlogiston necessary to bring it to a perfect state.

From the Ramelsberg ore after its first roasting a *white vitriol* is obtained and prepared at Goslar, whose basis was *zinc*: which proves that this ore contains also a certain quantity of this semimetal. As this ore is smelted in a country where the art is well understood of extracting every thing which a mineral contains, so in this fusion *zinc* and *cadmia* are obtained in the following manner: When the furnace is prepared for the fusion, it is necessary to close it up in the fore-part before the fusion is begun.

“First of all, a gritt-stone is to be placed, supported at the height of three inches. This stone is as long as the furnace is broad, and the height of it is level with the hole where the bellows-pipe enters. It is fastened on each side of the furnace, externally and in-

ternally, with clay. Upon this stone a kind of receptacle, or, as it is called, the *seat of the zinc*, is made in the following manner: A flat slaty stone is chosen, as long as the furnace is broad, and eight inches in breadth. This is placed on the gritt-stone above mentioned, in such a manner that it inclines considerably towards the front of the furnace, and that its bottom touches closely the gritt-stone. It is fastened with clay, which is also laid upon the seat of the zinc. Upon this seat, which is to receive the zinc, two round pieces of charcoal are placed, and also a stone called the *zinc-stone*, which is about a foot and an half in length, and closes one part of the front of the furnace. This stone also is fastened on each of its sides with clay. Clay is likewise put under the stone between the two pieces of charcoal, which hinder it from touching the seat of the zinc. The under-part of this stone is but slightly luted, that the workmen may make an opening for the zinc to flow out. Thus is made the seat or receptacle of the zinc to detain this metallic substance, which would otherwise fall into the hottest part of the fire, called by the workmen the *melting-place*, and would be there burnt: whereas it is collected upon this receptacle during the fusion, where it is sheltered from the action of the bellows, and consequently from too great heat.

“When all the matter to be fused in one day is put into the furnace, the blast of air is continued till that matter has sunk down. When it is half way down the furnace, they draw out the scoria, that more of the ore and other matters may be exposed to the greatest heat. As soon as the scoria is cooled and fixed a little, two shovel-fulls of small wet scoria or sand is thrown close to the furnace, and beat down with the shovel; then the workmen open the seat or receptacle of zinc, and strike upon the zinc-stone to make the semimetal flow out. As soon as the purest part of it has flowed out, it is sprinkled with water and carried away. Then the workmen separate entirely the zinc-stone from the wall of the furnace, and they continue to give it little strokes, that the small particles of zinc dispersed among the charcoal may fall down. This being done, the stone is removed; and the zinc is separated from the charcoal by an iron instrument, is cleaned, and remelted along with the zinc that flowed out at first, and is cast into round cakes. The reason why the zinc is withdrawn before the bellows cease to blow, is, that if it was left till the charcoal on the seat or receptacle was consumed, it would be mostly burnt, and little would be obtained. Thus after the zinc is withdrawn, the fusion is finished by blowing the bellows till the end.”

Thus the zinc is separated from the ore of Ramelsberg, and is not confounded in the hollow or casse with the lead and silver, because, being a volatile semimetal, it cannot support the activity of the fire without rising into vapours, which are condensed in the place least hot, that is to say, upon the stones expressly prepared for that purpose; and which, being much thinner than the other walls of the furnace, are continually cooled by the external air.

It is also in this furnace, and after the fusion of the Ramelsberg ore, that the *cadmia of zinc*, or the *cadmia of furnaces*, is obtained. This ore is composed of sulphureous and ferruginous pyrites, of true lead-

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lead-ore containing silver, and a very hard and compact matter of a dark brownish-grey colour, which is probably a *lapis calaminaris*, or an ore of zinc. These several matters of the Ramelsberg ore are not separated from each other, either for the roasting or for the fusion. Thus there is zinc in all the parts of the roasted ore; and much more of it would be obtained, if it was not so easily inflammable. All the zinc which is obtained is preserved from burning by falling, while in fusion, behind the chemise or fore-part of the furnace, which is, as has been said, a kind of schistus or slate, called by the workmen *steel-stone*. But the part of this semimetal which falls in the middle of the furnace, near the middle-wall, or towards the sides, being exposed to the greatest heat of the fire, is there burnt; and its smoke or flowers attaching itself on all sides to the walls of the furnace, undergo there a semi-fusion, which renders this matter so hard and so thick, that it must be taken away after every fourth fusion, or, at most, after every sixth fusion. That which is found attached to the highest part of the furnace is the best and purest. The rest is altered by a mixture of a portion of lead which it has carried up with it; and which, from its great weight and fixity, has hindered the zinc from rising so high as it would have done alone. Therefore, with this kind of impure cadmia, ductile brass cannot be made.

Almost all the zinc we have, as well as the cadmia of the furnaces, is obtained from the Ramelsberg ore by the process described, and consequently is not the produce of a pure ore of zinc or *lapis calaminaris*, which is never fused for that purpose. Before Mr Margraaf, although it was well known that this ore contained zinc, and that it was employed for the making of brass, a convenient process for extracting zinc from it was not known; because, when treated by fusion with fluxes, like other ores, it does not yield any zinc: which proceeds partly from the refractory quality of the earth contained in the calamine, that cannot be fused without a very violent fire; and also from the volatility and combustibility of the zinc, which for this reason cannot be collected at the bottom of a crucible, as a regulus under a scoria, like most metals.

M. Margraaf has remedied these inconveniences by distilling *lapis calaminaris*, mixed with charcoal, in a retort, to which is joined a receiver containing somewater, and consequently in close vessels, where the zinc, by the help of a very strong fire indeed, is sublimed in its metallic form without burning. He also by the same method reduced into zinc the *flowers of zinc*, or *pompholix*, *cadmia of the furnaces*, *tutty*, which is also a kind of cadmia; in a word, all matters capable of producing zinc by combination with phlogiston.—But it is evident that such operations as these are rather fit to supply proofs for chemical theory, than to be put in practice for works in great. M. Margraaf has observed, that the zinc which he obtained by this process was less brittle than what is obtained from the fusion of ores; which may proceed from its greater purity, or from its better combination with phlogiston.

Zinc is obtained, not only in the method used at Goslar above described; but is also extracted in great works, from *lapis calaminaris* and calcined blend, by a distillation similar to that by which M. Margraaf has

assayed ores of zinc. The first work of that kind was erected in Sweden by Mr Von Swab, in the year 1738. The ore employed was a kind of blend; this ore, when calcined, powdered, and mixed with charcoal, was put into iron or stone retorts, and the zinc was obtained by distillation. In Bristol a work is established in which zinc is obtained by distillation by descent.

After this digression which we have now made concerning the operation in the great by which zinc and cadmia are obtained, and which we could not insert elsewhere, because of the necessary relation it has with the smelting of the Ramelsberg ore, we proceed to the other operations of the same ore; that is to say, to the *finery*, by which the silver is separated from the lead, which are mixed together, forming what is called the *work*.

This operation differs from the *fining of assay*, or in *small*, principally in this circumstance, that in the latter method of fining all the litharge is absorbed into the cupel, whereas in the former method the greatest part of this litharge is withdrawn.

The fining in great of the work of Ramelsberg is performed in a furnace called a *reverberatory furnace*. This furnace is so constructed that the flame of wood burning in a cavity called the *fire-place*, is determined by a current of air (which is introduced through the ash-hole, and which goes out at an opening on one side of that part of the furnace where the work is, that is, where the lead and silver are) to circulate above, and to give the convenient degree of heat, when the fire is properly managed. In this furnace a great cupel, called a *test*, is disposed. This test is made of the ashes of beech-wood, well lixiviated in the usual manner. In some founderies different matters are added, as sand, spar, calcined gypsum, quicklime, clay. When the test is well prepared and dried, all the work is put at once upon the cold test, to the quantity of 64 quintals for one operation. Then the fire is lighted in the fire-place with faggots; but the fusion is not urged too fast, 1. That the test may have time to dry; 2. Because the work of the Ramelsberg ore is allayed by the mixture of several metallic matters, which it is proper to separate from it, otherwise they would spoil the litharge and the lead procured from it. These metallic matters are, copper, iron, zinc, and matt. As these heterogeneous substances are hard and refractory, they do not melt so soon as the work, that is, as the lead and silver; and when the work is melted, they swim upon its surface like a skin, which is to be taken off. These impurities are called the *scum* or the *first-waste*. What remains forms a second scum, which appears when the work is at its greatest degree of heat, but before the litharge begins to form itself. It is a scoria which is to be carefully taken off. It is called the *second waste*.

When the operation is at this point, it is continued by the help of bellows, the wind of which is directed, not upon the wood or fuel, but upon the very surface of the metal, by means of iron-plates put for that purpose before the blast-hole, which are called *papillons*. This blast does not so much increase the intensity of the fire, as it facilitates the combustion of the lead, and throws the litharge that is not imbibed by the test towards a channel, called the *litharge-way*, through which

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which it flows. The litharge becomes fixed out of the furnace: the matter which is found in the middle of the largest pieces, and which amounts to about a half or a third of the whole, is friable, and falls into powder like sand. This is put into barrels containing each five quintals of it; and is called *saleable litharge*, because it is sold in that state. The other part, which remains solid, is called *cold litharge*, and is again melted and reduced into lead. The fusion is called *cold fusion*, and the lead obtained from it *cold lead*, which is good and saleable when the work has been well cleared from the heterogeneous matters mentioned above. The tests and cupels impregnated with litharge are added in the fusion of the ore, as we have already related.

When two-thirds, or nearly that quantity, of the lead are converted into litharge, no more of it is formed. The silver then appears covered with a white skin, which the finers call *lightening*, and the metal *lightened* or *finer silver*.

The silver obtained by this process of fining is not yet altogether pure. It still contains some lead, frequently to the quantity of four drams in each marc, or eight ounces. It is delivered to the workmen, who complete its purification by the ordinary method. This last operation is the refining, and the workmen employed to do it are called *refiners*. A fining of 64 quintals of work, yields from 8 to 10 merks of finer silver, and from 35 to 40 quintals of litharge; that is, from 12 to 18 of saleable litharge, from 22 to 23 of cold litharge, from 20 to 22 quintals of impregnated test, and from 6 to 7 quintals of lead-dross. The operation lasts from 16 to 18 hours.

§ 2. Ores containing silver may be divided into four kinds, 1. Pure, or those which are not much compounded with other metals. 2. Galenical, in which the silver is mixed with much galena, or ore of lead mineralised by sulphur. 3. Pyritous, in which the silver is mixed with the martial pyrites. 4. Cupreous; in which the silver is contained in copper ores. To extract the silver from these several kinds of ores, different operations are necessary.

Native silver is separated from its adhering earths and stones by amalgamation with mercury in the manner directed for the separation of gold; or by fusion with lead, from which it may be afterwards separated by cupellation.

Pure ores seldom require a previous calcination; but when bruised and cleansed from extraneous matters, may be fused directly, and incorporated with a quantity of lead; unless they contain a large proportion of sulphur and arsenic, in which case a calcination may be useful. The lead employed must be in a calcined or vitrified state, which, being mixed with the ore, and gradually reduced by the phlogiston of the charcoal added to it, may be more effectually united with the silver of the ore, than if lead itself had been added, which would too quickly precipitate to the bottom of the containing vessel or furnace. The silver is to be afterwards separated from the lead by cupellation.

Galenical ores, especially those in which pyrites is intermixed, require a calcination, which ought to be performed in an oven, or reverberatory furnace. They are then to be fused together with some inflammable

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matter, as charcoal, by which the lead is revived, and together with the silver is precipitated.

Pyritous ores must be first melted, so as to form a matt. If the sulphur is not sufficient for this kind of fusion, more sulphurated pyrites may be added. This matt contains, besides silver and sulphur, also various metals, as lead, iron, and sometimes cobalt. The matt must be exposed to repeated calcinations till the sulphur is dissipated. By these calcinations most of the iron is destroyed. The calcined matt is to be fused with litharge, and the silver incorporated with the revived lead; from which, and from the other imperfect metals with which it may be mixed, it must afterwards be separated by cupellation.

The silver contained in cupreous ores may be obtained, either, 1. By separating it from the copper itself, after this has been extracted along with the silver, in the usual manner, from the ore; or, 2. By precipitating it immediately from the other matters of the ore.

1. It may be separated from the copper by two methods. One of these is by adding lead, and scorifying the imperfect metals. By this method much of the copper would be destroyed, and it is therefore not to be used unless the quantity of silver relatively to the copper be considerable. Another method by which silver may be separated from copper is by eliquation; that is, by mixing the mass of copper and silver with a quantity of lead, and applying such a heat as shall be just sufficient to make the lead eliquate from the copper, together with the silver, which being more strongly disposed to unite with the lead than with the copper, is thus incorporated with the former metal, and separated from the latter.

2. Silver may also be extracted from these cupreous ores by precipitation. For this purpose, let the ore, previously bruised and cleansed, be formed into a matt, that the earthy matters may be well separated. Let the matt be then fused with a strong heat; and when the scoria has been removed, and the heat is diminished, add to it some clean galena, litharge, and granulated lead. When the fire has been raised, and the additions well incorporated with the matt, let some cast or filed iron be thrown into the liquid mass, which, being more disposed than lead is to unite with sulphur, will separate and precipitate the latter metal, and along with it the silver or gold contained in the matt. This method was introduced by Scheffer, and is practised at Adelfors in Smoland. In this work the proportion of the several materials is, four quintals of matt, two quintals of black copper containing some lead with the perfect metal, one quintal of galena, one quintal of litharge, a fifth part of a quintal of granulated lead, and an equal quantity of cast iron.

The silver in this, and in all other instances where it is united with lead, is to be afterwards separated from the lead by cupellation; which process is described at the articles *Essay of the Value of Silver*, and *REFINING*.

SECT. IV. Smelting of Ores of Copper.

§ 1. THE smelting in great of copper ores, and even of several ores of silver and lead, excepting that of Ramelsherg, is performed in furnaces not essentially different

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ferent from that already described; but in this respect only, that the scoria and metal are not drawn out of the furnace, but flow spontaneously, as soon as they are melted, into receiving basons, where the metal is freed from the scoria. These furnaces are generally called *pierced furnaces*.

Instead of a light brasque, or bed of charcoal powder, under which the metal lies hid, the bottom of these furnaces is covered with a bason composed of heavy brasque, which is a mixture of charcoal-powder and clay. In the front of the furnace, and at the bottom of the chemise, there is a hole, called the *eye*, through which the melted matter flows, and runs along a trench or furrow, called the *trace*, into one or more receiving basons made of earth, scoria, sand, &c. There the metal is separated from the scoria, by making it flow from these basons into another lateral one. These furnaces are also called *crooked furnaces*.

Different names are given to them according to some difference in their construction. For instance, those which have two eyes, and two traces, through which the melted matter flows alternately into two basons, are called *spectacle-furnaces*. Their greater or less height gives occasion also to the distinction of *high furnaces* and *middle furnaces*.

The high furnaces are of modern invention. They were first introduced at Mansfeldt in the year 1727; and they are now used in almost all countries where ores are smelted, as in Saxony, Bohemia, Hungary, &c. Their chief advantage consists in simplifying and diminishing the labour. This advantage is effected by the great height of the furnace, which allows the ore to remain there a long time before it falls down into the hottest part of the fire and is melted. Consequently, it suffers successively different degrees of heat; and, before it is melted, it undergoes a roasting which costs nothing: therefore the high furnaces are chiefly employed for crude fusions; and particularly for the slate-copper ore. These furnaces are above 18 feet high. A too great height is attended with an inconvenience, besides the trouble of supplying it with ore and fuel, which is, that the charcoal is mostly consumed before it gets down where the greatest heat is required, and is then rendered incapable of maintaining a fire sufficiently intense.

All the furnaces which we have mentioned are supplied with large bellows, moved by the arbor of a wheel, which is turned round by a current of water.

The only kind of furnace for smelting ores where bellows are not employed, is what is called a *reverberatory furnace*. The Germans call it a *wind furnace*. It is also distinguished by the name of *English furnace*, because the invention of it is attributed to an English physician of the name of *Wright*, who was well versed in chemistry; and because the use of it was first introduced in England about the end of the last century, where it is much employed, as well as in several other countries, as at Konigsberg, in Norway.

The length of these furnaces is about 18 feet, comprehending the masonry: their breadth is 12 feet, and their height nine feet and a half. The hearth is raised

three feet above the level of the foundry: on one side is the fire-place, under which is an ash-hole hollowed in the earth; on the other side is a bason made, which is kept covered with fire when there is occasion: on the anterior side of this furnace there is a chimney, which receives the flame after it has passed over the mineral that is laid upon the hearth. This hearth, which is in the interior part of the furnace, is made of a clay capable of sustaining the fire. The advantage of this furnace is, that bellows are not necessary; and consequently it may be constructed where there is no current of water, and wherever the mine happens to be. This furnace has a hole in its front, through which the scoria is drawn out; and a bason, as we have said, on one side, made with sand, in which are oblong traces for the reception of the matt, and of the black copper, when they flow out of the furnace.

Copper is generally mineralised, not only by sulphur and arsenic, but also by semimetals and pyritous matters, and is frequently mixed with other metals. As this metal has great affinity with sulphur and arsenic, it is almost impossible to disengage it from them entirely by roasting: hence, in the smelting in great, nothing is obtained by the first operation but a copper matt, which contains all the principles of the ore, excepting the earthy and stony parts, particularly when the ore is smelted crude and unroasted. Afterwards this matt must be again roasted and fused. The produce of this second fusion begins still more to resemble copper, but is not malleable. It continues mixed with almost all the minerals, particularly with the metals. As it is frequently of a black colour, it is always called *black copper*, when it is unmalleable, whatever its colour happens really to be.

As, of all the imperfect metals, copper is most difficultly burnt and scorified, it is again remelted several times, in order to burn and scorify the metallic substances mixed with it; and this is done till the copper is perfectly pure, which is then called *red* or *refined copper*, and these last fusions are called the *fining* and *refining* of it: red copper contains no metals but gold and silver, if any of these happened to be in the ore.

In order to avoid all these fusions, it has been proposed to treat in the humid way certain copper ores, particularly those which are very pyritous. This method consists in making blue vitriol from the ore, by roasting and lixiviating it, and in precipitating pure copper from this lixivium, which is called *cement-water*, by means of iron: but it is not much practised, because it has been observed, that all the copper contained in the ore was not procured by this means.

As expence is not much regarded in small essays and experiments, these fusions are much abridged and facilitated by adding at first saline and glassy fluxes; and then by refining the black copper with lead in the cupel, as gold and silver are done. In this method of refining, it is to be most carefully observed, that the metal be fused as quickly as possible, and exposed to no more heat than is necessary, lest it be calcined.

When the black copper contains some iron, but not a great

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a great deal, the lead presently separates the iron from it, and makes it rise to the surface of the copper: but if the iron be in too large a proportion, it prevents the lead from uniting with the copper. These two phenomena depend on the same cause, which is, that lead and iron cannot unite.

Frequently copper ores contain also a quantity of silver sufficient to make its extraction by particular processes profitable. It was long before any process could be thought of for this purpose which was not too expensive and troublesome: but at length it is accomplished by the excellent operation called *eliquation*.

The copper from which silver has been separated by *eliquation* must be refined after this operation, as it is generally black copper from which silver is extracted: but even if it had not been black copper which was employed for this operation, it would require to be refined on account of a little lead it always retains. It is therefore carried to the refiner's furnace, when this operation is performed by help of bellows, the blast of which is thrown upon the surface of the melted metal. As in this refining of copper the precise time when it becomes pure cannot be known, because scoria is always formed on its surface, it is necessary to use an assay-iron, the polished end of which being dipt in melted copper, shows that this metal is pure when the copper adhering to the iron falls off as soon as it is dipt in cold water.

When this mark of the purity of the copper has been observed, its surface ought to be well cleaned; and as soon as it begins to fix, it must be sprinkled with a broom or besom dipped in cold water. The surface of the copper which is then fixing, being suddenly cooled by the water, detaches itself from the rest of the metal, is taken hold of by tongs, and is thrown red-hot into cold water. By again sprinkling water on the mass of copper, it is all of it reduced into plates, which are called *rosettes*, and these plates are what is called *rosette-copper*.

§ 2. The copper of pyritous cupreous ores cannot be obtained without several operations, which vary according to the nature of the ores. These operations are chiefly roastings and fusions. By the first fusion a matt is produced, which is afterwards to be roasted; and thus the fusions and roastings are to be alternately applied, till by the last fusion copper is obtained. These methods of treating pyritous copper ores depend on the two following facts: 1. Sulphur is more disposed to unite with iron than with copper. 2. The iron of these ores is destructible by the burning sulphur during the roasting or the fusion of the ores, while the copper is not injured. This fact appears from experiments mentioned by Scheffer and by Wallerius, and from the daily practice of smelting cupreous ores.

From these facts we learn, 1. That sulphur may be employed to separate and destroy iron mixed with copper. 2. That iron may be employed to separate the sulphur from copper, as is sometimes done in the assay of sulphurated copper-ores. 3. That by adjusting the proportions of the iron and sulphur to each other in the smelting of copper-ores, these two substances may be made to destroy each other, and to procure a separation of the copper: and this adjustment

may be effected, by adding sulphur or sulphureous pyrites to the copper-ore, when the quantity of sulphur contained in this ore relatively to the iron is too small; or by adding iron when the sulphur predominates; or by roasting, by which the superfluous sulphur may be expelled, and no more left than is sufficient for the destruction of the iron contained in the ore. We shall apply these principles to the following cases.

1. When the quantity of sulphur and of iron in a copper-ore is small, and especially when the iron does not too much abound, a previous roasting will at once calcine the iron, and expel most of the sulphur; so that by one fusion the calcined iron may be scorified, and black copper may be obtained. If the sulphur has not been sufficiently expelled, a second roasting and fusion are requisite; for the whole quantity of sulphur ought not to be expelled during the first roasting: but as much ought to be left as is sufficient for the scorification of the calcined iron; otherwise this might, during the fusion, be again revived and united with the copper.

2. If, in a copper ore, the quantity of iron be too great, relatively to the sulphur, some sulphurated pyrites, especially that kind which contains copper, ought to be added, that a matt may be obtained, and that the iron may be calcined and scorified.

3. When the quantity of sulphur and iron is very great, that is, when the ore is very pyritous and poor, it ought to be first formed into a matt; by which it is separated from the adherent earths and stones, and the bulk is diminished: then by repeated and alternate roastings and fusions, the copper may be obtained.

4. When the quantity of sulphur in an ore is greater than is sufficient for the forming a matt, the superfluous quantity ought to be previously expelled by roasting.

The copper thus at first obtained is never pure, but is generally mixed with sulphur or with iron. It is called *black copper*. This may be refined in furnaces, or on hearths.

In the former method, to the copper when melted a small quantity of lead is added, which unites with the sulphur, and is scorified together with the iron, and floats upon the surface of the melted copper. This purification of copper by means of lead is similar to the refining of silver by cupellation; and is founded on the property of lead, by which it is more disposed to unite with sulphur than copper is; and on a property of copper, by which it is less liable than any other imperfect metal to be scorified by lead. But as copper is also capable of being scorified by lead, this operation must be no longer continued, and no more lead must be employed, than is sufficient for the separation of the sulphur, and for the scorification of the iron.

The copper might also be purified from any remaining sulphur by adding a sufficient quantity of iron to engage the sulphur. Thus Mr Scheffer found, that by adding to sulphurated copper from $\frac{1}{15}$ th to $\frac{1}{10}$ th of old cast iron, he rendered the copper pure and ductile. See his Dissertation on the Parting of Metals amongst the *Swedish Memoirs* for the year 1752. In this purification, the quantity of iron added ought not to be too

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little, else all the sulphur will not be separated; and it ought not to be too great, else the superfluous quantity will unite with and injure the purity of the copper. The fusion and scorification, with addition of lead, seems to be the best method for the last purification of copper.

SECT. V. *Smelting, &c. of Ores of Iron.*

NOTWITHSTANDING the great importance of this subject, and the labours of Reaumur, Swedenborgius, and of some other authors, we have still a very imperfect knowledge of the causes of the differences of the several kinds of ores, of the methods of smelting best adapted to these differences, of the causes of the good and bad qualities of different kinds of iron, and of the means of so meliorating this metal, that we may obtain tough and ductile iron from any of its ores.

Swedenborgius has very industriously and exactly described the different processes now used in most parts of Europe for the smelting of ores of iron, for the forging of that metal, and for the conversion of it into steel: but we do not find that he or any other author have, by experiments and discoveries, contributed much to the illustration or to the improvement of this part of metallurgy, unless, perhaps, we except those of Mr Reaumur, concerning the softening of cast iron by cementation with earthy substances.

The ores of iron are known to vary much in their appearance, in their contents, in their degrees of fusibility, in the methods necessary for the extraction of their contained metal, and in the qualities of the metal when extracted.

Most ores require to be roasted previously to their fusion; some more slightly, and others with a more violent and longer-continued fire. Those which contain much sulphur, arsenic, or vitriolic-acid, require a long-continued and repeated roasting, that the volatile matters may be expelled. Of this kind is the black-iron ore, from which the Swedish iron is said to be obtained.

Some ores require a very slight roasting only, that they may be dried and rendered friable.—Such are the ores called *bog ores*, and others, which being in a calcined state, and containing little sulphureous matter, would, by a farther calcination, be rendered less capable of being reduced to a metallic state.

The roasting of ores of iron is performed by kindling piles, consisting of strata of fuel and of ore placed alternately upon one another, or in furnaces similar to those commonly employed for the calcination of limestone.

Some authors advise the addition of a calcareous earth to sulphureous ores during the roasting, that the sulphur may be absorbed by this earth when converted into quicklime. But we may observe, that the quicklime cannot absorb the sulphur or sulphureous acid, till these be first extricated from the ore, and does therefore only prevent the dissipation of these volatile matters; and, secondly, that the sulphur thus united with the quicklime forms a hepar of sulphur, which will unite with and dissolve the

ore during its fusion, and prevent the precipitation of the metal.

The next operation is the *fusion* or *smelting* of the ore. This is generally performed in furnaces or towers, from 20 to 30 feet high, in the bottom of which is a basin for the reception of the fluid metal. When the furnace is sufficiently heated, which must be done at first very gradually, to prevent the cracking of the walls; a quantity of the ore is to be thrown in, from time to time, at the top of the furnace, along with a certain quantity of fuel and of lime-stone, or whatever other flux is employed. When the fuel below is consumed by the fire excited by the wind of the bellows, the ore, together with its proportionable quantity of fuel and of flux, sink gradually down, till they are exposed to the greatest heat in the furnace. There the ore and the flux are fused, the metallic particles are revived by the fuel, are precipitated by means of their weight through the scoria formed of the lighter earthy parts of the flux and of the ore, and unite in the basin at the bottom of the furnace, forming a mass of fluid metal covered by a glassy scoria. When a sufficient quantity of this fluid metal is collected, which is generally twice or thrice in 24 hours, an aperture is made, through which the metal flows into a channel or groove made in a bed of sand; and from thence into smaller lateral or connected channels, or other moulds. There it is cooled, becomes solid, and retains the forms of the channels or moulds into which it flows. The piece of iron formed in the large channel is called a *row*, and those formed in the smaller channels are called *pigs*. Sometimes the fluid iron is taken out of the furnace by means of ladles, and poured into moulds ready prepared, of sand or of clay, and is thus formed into the various utensils and instruments for which cast iron is a proper material.

The *scoria* must be, from time to time, allowed to flow out, when a considerable quantity of it is formed, through an aperture made in the front of the furnace for that purpose. A sufficient quantity of it must, however, be always left to cover the surface of the melted iron, else the ore which would fall upon it, before the separation of its metallic from its unmetallic parts, would lessen the fluidity and injure the purity of the melted metal. This scoria ought to have a certain degree of fluidity; for if it be too thick, the revived metallic particles will not be able to overcome its tenacity, and collect together into drops, nor be precipitated. Accordingly, a scoria not sufficiently fluid, is always found to contain much metal. If the scoria be too thin, the metallic particles of the ore will be precipitated before they are sufficiently metallised, and separated from the earthy and unmetallic parts. A due degree of fluidity is given to the scoria by applying a proper heat, and by adding fluxes suited to the ore.

Some ores are fusible without addition, and others cannot be smelted without the addition of substances capable of facilitating their fusion.

The *fusible ores* are those which contain sulphur, arsenic, or are mixed with some fusible earth.

The *ores difficultly fusible* are those which contain no mixture of other substance. Such are most of the

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ores which contain iron in a state nearly metallic. As iron itself, when purified from all heterogeneous matters, is scarcely fusible without addition, so the metal contained in these purer kinds of ores cannot be easily extracted without the addition of some fusible substance. 2. Those which are mixed with some very refractory substance. Some of these refractory ores contain arsenic; but as this substance facilitates the fusion of ores, we may presume that their refractory quality depends upon a mixture of some unmetallic earth or other unfusible substance. The earth which is mixed with the common calciform ores is in considerable quantity; and is sometimes calcareous, sometimes siliceous, and sometimes argillaceous.

Perhaps the fusibility of different ores depends greatly on the degree of calcination to which the metal contained in them has been reduced; since we have reason to believe, that by a very perfect calcination, some metals at least may be reduced to the state of an earth almost unfusible, and incapable of metallisation; and since we know, that in every calcination and subsequent reduction of a given quantity of any imperfect metal, a sensible part of that quantity is always lost or destroyed, however carefully these operations may have been performed. That some of these ores are already too much calcined, appears from the instance above-mentioned of the *bog ores*, which are injured by roasting; and even the great height of the common smelting furnaces, although advantageous to many ores that require much roasting, is said to be injurious to those which are already too much calcined, by exposing them to a further calcination, during their very gradual descent, before they arrive at the hottest part of the furnace, where they are fused.

But as too violent calcination renders some ores difficultly fusible, so too slight calcination of other ores injures the purity of the metal, by leaving much of the sulphureous or other volatile matter, which ought to have been expelled.

Various substances are added to assist the fusion of ores difficultly fusible. These are, 1. Ores of a fusible quality, or which, being mixed with others of a different quality, become fusible: accordingly, in the great works for smelting ores of iron, two or more different kinds of ore are commonly mixed, to facilitate the fusion, and also to meliorate the quality of the iron. Thus an ore yielding an iron which is brittle when hot, which quality is called *red-short*, and another ore which produces iron brittle when cold, or *cold-short*, are often mixed together; not, as sometimes supposed, that these qualities are mutually destructive of each other, but that of each of them is diminished in the mixed mass of iron, as much as this mass is larger than the part of the mass originally possessed of that quality. Thus, if from two such ores the mass of iron obtained consists of equal parts of cold-short and of red-short iron, it will have both these qualities, but will be only half as *cold-short* as iron obtained solely from one of the ores, and half as *red-short* as iron obtained only from the other ore. 2. Earths and stones are also generally added to facilitate the fusion of iron ores. These are such as are fusible, or become fusible when mixed with the ore, or with the earth adhering to it. Authors

direct that, if this earth be of an argillaceous nature, limestone or some calcareous earth should be added; and that, if the adherent earth be calcareous, an argillaceous or siliceous earth should be added; because these two earths, though singly unfusible, yet, when mixed, mutually promote the fusion of each other: but as limestone is almost always added in the smelting of iron ores, and as in some of these, at least, no argillaceous earth appears to be contained, we are inclined to believe, that it generally facilitates the fusion, not merely by uniting with those earths, but by uniting with that part of the ore which is most perfectly calcined, and least disposed to metallisation; since we know, that by mixing a calciform or roasted ore of iron with calcareous earth, without any inflammable matter, these two substances may be totally vitrified. See *Experiments made upon quicklime and upon iron, by Mr Brandt, in the Swedish Memoirs for the years 1749 and 1751*. Calcareous earth does indeed so powerfully facilitate the fusion of iron ores, that it deserves to be considered whether workmen do not generally use too great a quantity of it, in order to hasten the operation. For when the scoria is rendered too thin, much earthy or unmetallised matter is precipitated, and the cast iron produced is of too vitreous a quality, and not sufficiently approximated to its true metallic state.

Some authors pretend, that a principal use of the addition of limestone in the smelting of iron ores is to absorb the sulphur, or vitriolic acid, of these ores: but, as we have already observed, a hepar of sulphur is formed by that mixture of calcareous earth and sulphur, which is capable of dissolving iron in a metallic state; and thus the quantity of metal obtained from an ore not sufficiently divested of its sulphur, or vitriolic acid, (which, by uniting with the fuel, is formed into a sulphur during the smelting), must be considerably diminished, though rendered purer, by addition of calcareous earth: hence the utility appears of previously expelling the sulphur and vitriolic acid from the ore by a sufficient roasting. 3. The *scoria* of former smeltings is frequently added to assist the fusion of the ore; and, when the scoria contains much iron, as sometimes happens in ill-conducted operations, it also increases the quantity of metal obtained.

The quantity of these fusible matters to be added varies according to the nature of the ore; but ought in general to be such, that the scoria shall have its requisite degree of thinness, as is mentioned above.

The fuel used in most parts of Europe for the smelting of ores of iron is charcoal. Lately, in several works in England and Scotland, iron ore has been smelted by means of pit-coal, previously reduced to cinders or *coaks*, by a kind of calcination similar to the operation for converting wood into charcoal, by which the aqueous and sulphureous parts of the coal are expelled, while only the more fixed bituminous parts are left behind. In France, pit-coal not calcined has been tried for this purpose, but unsuccessfully. The use of *peat* has also been introduced in some parts of England.

The quality of the iron depends considerably upon the quality and also upon the quantity of the fuel employed. Charcoal is fitter than coaks for producing

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ducing an iron capable of being rendered malleable by forging.

The quantity of fuel, or the intensity of the heat, must be suited to the greater or less fusibility of the ore. Sulphureous, and other ores easily fusible, require less fuel than ores difficultly fusible. In general, if the *quantity of fuel be too small*, and the heat not sufficiently intense, all the iron will not be reduced, and much of it will remain in the scoria, which will not be sufficiently thin. This defect of fuel may be known by the blackness and compactness of the scoria; by the qualities of the iron obtained, which in this case is hard, white, light, intermixed with scoria, smooth in its texture, without scales or grains, rough and convex in its surface, and liable to great loss of weight by being forged; and, lastly, it may be known by observing the colour and appearance of the drops of metal falling down from the smelted ore, and of the scoria upon the surface of the fluid metal, both which are darker-coloured than when more fuel is used. When the *quantity of fuel is sufficiently large*, and the heat is intense enough, the iron is darker-coloured, denser, more tenacious, contains less scoria, and is therefore less fusible, and loses less of its weight by being forged. Its surface is also smoother and somewhat concave; and its texture is generally granulated. The scoria, in this case, is of a lighter colour, and less dense. The drops falling down from the smelted ore and the liquid scoria in the furnace appear hotter and of a brighter colour. When the quantity of fuel is too great, and the heat too intense, the iron will appear to have a still darker colour, and more conspicuous grains or plates, and the scoria will be lighter, whiter, and more spongy. The drops falling from this smelted ore, and the fluid scoria, will appear to a person looking into the furnace through the blast-hole to be very white and shining hot. The quantity of charcoal necessary to produce five hundred weight of iron, when the ore is rich, the furnace well contrived, and the operation skilfully conducted, is computed to be about 40 cubic feet; but is much more in contrary circumstances.

The time, during which the fluid metal ought to be kept in fusion before it is allowed to flow out of the furnace, must also be attended to. How long that time is, and whether it ought not to vary according to the qualities of ores and other circumstances, we cannot determine. In some works the metal is allowed to flow out of the furnace every six or eight, and in others only every 10 or 12, hours. Some workmen imagine, that a considerable time is necessary for the concoction of the metal. This is certain, that the iron undergoes some change by being kept in a fluid state; and that if its fusion be prolonged much beyond the usual time, it is rendered less fluid, and also its cohesion, when it becomes cold, is thereby greatly diminished. The marquis de Courtivron says, that the cohesion may be restored to iron in this state, by adding to it some vitrescible earth, which he considers as one of the constituent parts of iron, and which he thinks is destroyed by the fusion too long continued. That the fusibility of cast-iron does depend on an admixture of some vitrescible earth, appears probable from the great quantity of scoria forced out of iron during its conversion into malleable

or forged iron, and from the loss of fusibility which it suffers nearly in proportion to its loss of scoria. The quantity of iron daily obtained from such a furnace as is above described, is from two to five tons in 24 hours, according to the richness and fusibility of the ore, to the construction of the furnace, to the adjustment of the due quantity of flux and of fuel, and to the skill employed in conducting the operation.

The *quality of the iron* is judged of by observing the appearances during its flowing from the furnace, and when it is fixed and cold. If the fluid iron, while it flows, emits many and large sparkles; if many brown spots appear on it while it is yet red-hot; if, when it is fixed and cold, its corners and edges are thick and rough, and its surface is spotted; it is known to have a red-short quality. If, in flowing, the iron seems covered with a thin glassy crust, and if, when cold, its texture be whitish, it is believed to be cold-short. Mr Reaumur says, that dark-coloured cast iron is more impure than that which is white. The marquis de Courtivron is of a contrary opinion. But no certain rules for judging of the quality of iron before it be forged can be given. From brittle cast-iron, sometimes ductile forged iron is produced. Cast-iron with brilliant plates and points, when forged, becomes sometimes red-short and sometimes cold-short. Large shining plates, large cavities called *eyes*, want of sufficient density, are almost certain marks of bad iron; but whether it will be cold or red short cannot be affirmed till it be forged. Whiteness of colour, brittleness, closeness of texture, and hardness, are given to almost any cast iron by sudden cooling; and we may observe, that in general the whiter the metal is, the harder it is also, whether these properties proceed from the quality of the iron, or from sudden cooling; and that, therefore, the darker-coloured iron is fitter for being cast into moulds, because it is capable in some measure of being filed and polished, especially after it has been exposed during several hours to a red-heat in a reverberatory furnace, and very gradually cooled. This operation, called by the workmen *annealing*, changes the texture of the metal, renders it softer, and more capable of being filed than before, and also considerably less brittle.

Mr Reaumur found, that by cementing cast iron with absorbent earths in a red-heat, the metal may be rendered softer, tougher, and consequently a fit material for many utensils formerly made of forged iron. Whether cementation with absorbent earths gives to cast iron a greater degree of these properties than the annealing commonly practised, has not been yet determined.

In Navarre, and in some of the southern parts of France, iron-ore is smelted in furnaces much smaller, and of a very different construction from those above described. A furnace of this kind consists of a wide-mouthed copper-caldron, the inner surface of which is lined with masonry a foot thick. The mouth of this caldron is nearly of an oval or elliptic form. The space or cavity contained by the masonry is the furnace in which the ore is smelted. The depth of this cavity is equal to two feet and a half: the larger diameter of the oval mouth of the cavity is about eight feet, and its smaller diameter is about six feet: the space of the furnace is gradually contracted towards the bottom,

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bottom, the greatest diameter of which does not exceed six feet: eighteen inches above the bottom is a cylindrical channel in one of the longer sides of the caldron and masonry, through which the nozzle of the bellows passes. This channel, and also the bellows pipe, are so inclined, that the wind is directed towards the lowest point of the opposite side of the furnace. Another cylindrical channel is in one of the shorter sides of the furnace, at the height of a few inches from the bottom, which is generally kept closed, and is opened occasionally to give passage to the scoria: and above this is a third channel in the same side of the furnace, through which an iron instrument is occasionally introduced to stir the fluid metal, and to assist, as is said, the separation of the scoria from it. The greatest height of this channel is at its external aperture on the outside of the furnace, and its smaller height is at its internal aperture; so that the instrument may be directed towards the bottom of the furnace; but the second channel below it has a contrary inclination, that, when an opening is made, the scoria may flow out of the furnace into a basin placed for its reception. When the furnace is heated sufficiently, the workmen begin to throw into it alternate changes of charcoal and of ore previously roasted. They take care to throw the charcoal chiefly on that side at which the wind enters, and the ore at the opposite side. At the end of about four hours, a mass of iron is collected at the bottom of the furnace, which is generally about 600 weight; the bellows are then stopt; and when the mass of iron is become solid, the workmen raise it from the bottom of the furnace, and place it, while yet soft, under a large hammer, where it is forged. The iron produced in these furnaces is of the best quality; the quantity is also very considerable, in proportion to the quantity of ore, and to the quantity of fuel employed. In these furnaces no limestone or other substance is used to facilitate the fusion of the ore. We should receive much instruction concerning the smelting of iron-ore, if we knew upon what part of the process, or circumstance, the excellence of the iron obtained in these furnaces depends; whether on the quality of the ore; on the disuse of any kind of flux, by which the proportion of vitreous or earthy matter, intermixed with the metallic particles, is diminished; on the forging while the iron is yet soft and hot, as the Marquis de Courtivron thinks; or on some other cause, not observed.

The iron thus produced by smelting ores is very far from being a pure metal; and though its fusibility renders it very useful for the formation of cannon, pots, and a great variety of utensils, yet it wants the strength, toughness, and malleability, which it is capable of receiving by further operations.

Cast-iron seems to contain a large quantity of vitreous or earthy matter mixed with the pure iron; which matter is probably the chief cause of its fusibility, brittleness, hardness, and other properties by which it differs from forged iron. The sulphur, arsenic, and other impurities of the ore, which are sometimes contained in cast-iron, are probably only accidental, and may be the causes of the red-short quality, and of other properties of certain kinds of iron: but the earthy matter above-mentioned seems principally to distinguish cast-iron from forged or malleable iron;

for, first, by depriving the former of this earthy matter, it is rendered malleable, as in the common process hereafter to be described; and, secondly, by fusing malleable iron with earthy and vitrescible matters, it loses its malleability, and is restored to the state and properties of cast-iron.

The earthy vitreous matter contained in cast-iron consists probably of some of the ferruginous earth or calx of the ore not sufficiently metallised, and also of some unmetallic earth. Perhaps it is only a part of the scoria which adheres to, and is precipitated with, the metallic particles, from which it is more and more separated, as the heat applied is more intense, and as the fusion is longer continued.

To separate these impurities from cast-iron, and to unite the metallic parts more closely and compactly, and thus to give it the ductility and tenacity which render this metal more useful than any other, are the effects produced by the following operations.

The first of these operations is a fusion of the iron, by which much of its impurities is separated in form of scoria; and by the second operation, a further and more complete separation of these impurities, and also a closer compaction of the metallic particles, are effected by the application of mechanical force or pressure, by means of large hammers.

Some differences in the construction of the forge or furnace, in which the *fusion* or *refining* of cast-iron is performed, in the method of conducting the operation, and in other circumstances, are observed to occur in different places. We shall describe from Swedenborgius the *German method*.

The fusion of the cast-iron, which is to be rendered malleable, is performed upon the hearth of a forge similar to that used by blacksmiths: at one side of this hearth is formed a cavity or fire-place, which is intended to contain the fuel and the iron to be melted: this fire-place is 20 inches long, 18 inches broad, and 12 or 14 inches deep: it is bounded on three sides by three plates of cast-iron placed upright; and on the fourth side, which is the front, or that part nearest to which the workmen stand, by a large forge-hammer, through the eye of which the scoria is at certain times allowed to flow. The floor also of the fire-place is another cast-iron plate. The thickness of these plates is from two to four inches. One of the upright side-plates rests against a wall, in an aperture through which a copper-tube, called the *tuyere*, is luted with clay. This tube is a kind of case or covering for the pipe of a pair of bellows placed behind the wall, and its direction is therefore parallel to that of the bellows-pipe; but it advances about half a foot further than this pipe into the fire-place; and thus gives greater force to the air, which it keeps concentrated, or prevents the divergency of the air till it is required to act. The tube rests upon the edge of the side-plate which leans against the wall, nearer to the back-part than to the front of the fire-place; and in such an oblique direction, that the wind shall be impelled towards the furthest part of the floor of the fire-place, or where this floor is intersected by the opposite side-plate. The obliquity of the tuyere ought to vary according to the quality of the iron: and therefore, in every operation, it may be shifted till its proper position is found. The more nearly its direction approaches

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proaches to a horizontal plane, the more intense is the heat; but a larger quantity of fuel is consumed than is even proportional to the increase of heat, because the flame is not then so well confined. When the iron is easily fusible, great heat is not required: the tuyere may then decline considerably from the horizontal plane, and thus fuel may be saved. This tuyere, tho' made of copper, a metal more easily fusible than iron, is preserved from fusion by the constant passage of cold air through it. It must be carefully kept open, and cleansed from the scoria, which would be apt to block up its cavity, by which not only the heat would be too much diminished for the success of the operation, but the tube itself would be melted.

To prepare for the fusion, a quantity of scoria of a former operation is thrown into the fire-place, till one third-part of this be full; and the remaining two thirds of the fire-place are to be filled with smaller scoria, coal-dust, and sparks ejected from hot iron.—These matters, being fusible, form a bath for the reception of the iron when melted. Upon this bed of scoria, the mass of cast iron to be melted is placed; so that one end of it shall be within the fire-place, opposite to the tuyere, and at the distance of about four or five inches from its aperture; and the other end shall stand without the fire-place, to be pushed in, as the former is melted. The upper side of the mass of iron ought to be in the same horizontal plane as the upper part of the orifice of the tuyere, that the wind may, by means of the obliquity of its course, strike upon and pass along the under-side of the mass; but if the iron be difficultly fusible, the tuyere is to be disposed more horizontally, so that the wind shall strike directly upon the mass of iron; and that one part of the blast shall graze along the upper surface, and the other part along the under surface of the iron. The mass of iron weighs generally from 200 to 400 pounds. Sometimes two or three smaller masses are put one above another, so as not to touch. When these are of different qualities, the cold-short piece is placed undermost, that being more unfusible than the red-short. The iron being placed, charcoal-powder is thrown on both sides, and coals are accumulated above, so as to cover entirely the iron.

The coals are then to be kindled, and the bellows are made to blow, at first slowly, and afterwards with more and more force. The iron is gradually liquefied, and flows down in drops through the melted scoria to the bottom of the fire-place; during which the workmen frequently turn the iron, so that the end opposed to the blast of wind may be equally exposed to heat, and uniformly fused. While the coals are consumed, more are thrown on, so that the whole may be kept quite covered. During the operation, a workman frequently sounds the bottom and corners of the fire-place by means of a bar or poker, raises up any mass of metal which he finds adhering to these, and exposes them to the greatest heat, that they may be more perfectly fused.

When all the iron is fused, no more coals are to be added; but the melted mass is to remain half uncovered for some time; during which the iron boils and bubbles, and its surface swells and rises higher and higher. When the iron has risen as high as the upper edge of the fire-place, the coals upon its surface

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must be removed; and by thus exposing it to cold air, its ebullition and swelling subside. In this state, or coction, the iron is kept during half an hour or more, by adding occasionally pieces of good coal, which maintain a sufficient heat, without covering entirely the surface of the mass. During this coction, the workmen allow the orifice of the tuyere to be half stopped up by the scoria, that the air may not blow upon the iron with all its force, by which it would be too much cooled. Accordingly, when they think that the coction has continued sufficiently long, they clear the passage of the tuyere, and the mass is soon cooled by the cold air. At the same time also they open a passage in the eye of the hammer placed in the front of the fire-place, through which some of the scoria is allowed to flow out. When the iron has become solid, the bellows are stopt, the coals are removed, and the mass is left during an hour; and then the workmen raise it from the fire-place, turn it upside down, and proceed to the second coction or fusion of the iron.

From this second operation, the mass is to be so placed, that one part of it shall rest upon the tuyere, and the other upon the scoria remaining in the fire-place. This scoria is to be disposed in an oblique direction parallel to the tuyere, by which means the wind of the bellows is obliged to pass along the under side of the mass of iron. About the sides of the mass, charcoal-powder and burnt ashes are thrown; but towards the tuyere, dry and entire pieces of coals are placed, to maintain the fire. When these are kindled, more coals are added, and the fire is gradually excited. The workman attends to the direction of the flame, that it pass equally along the under surface of the iron, quite to the further extremity, and that it do not escape at the sides, nor be reverberated back towards the tuyere, by which this copper tube might be melted. During this fusion, pieces of iron are apt to be separated from the mass, and to fall down unfused to the bottom and corners of the fire-place. These are carefully to be searched for, and exposed to the greatest heat till they are melted. When the whole mass is thus brought into perfect fusion, the coals are removed; and the wind blowing on its surface, whirls and dissipates the small remaining pieces of scoria and sparks thrown out from the fluid iron. This jet of fire continues about seven or eight minutes, and the whole operation about two hours. In this second fusion the scoria is to be thrice removed, by opening a passage through the eye of the hammer. The first time of removing the scoria is about 20 minutes from the kindling of the fire, the second time is about 40 minutes after the first, and the third time is near the end of the operation.

The mass is then removed from the hearth, and put upon the ground of the forge, where it is cleansed from scoria, and beat into a more uniform shape. It is then placed on an anvil, where, by being forged, it receives a form nearly cubical. This mass is to be divided into five, six, or more pieces, by means of a wedge; and these are to be heated and forged till they are reduced to the form of the bars commonly sold.

In some forges, the iron is fused only once, and in others it suffers three fusions, by which it is said to be rendered

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rendered very pure. Where only one fusion is practised, it is called the *French method*. In this, no greater quantity of iron is fused at once than is sufficient to make one bar. The fire-place is of considerably less dimensions, and especially is less deep, than in the German method above described. The fire is also more intense, and the proportion of fuel consumed to the iron is greater. The iron, when melted, is not kept in a state of ebullition as is above described; but this ebullition is prevented by stirring the fluid mass with an iron bar, till it is coagulated, and becomes solid.

By these operations, fusion and forging, the iron loses about $\frac{1}{4}$ parts of its former weight, sometimes more and sometimes less, according to the quality of the cast-iron employed; it is purified from the vitreous and earthy parts which were intermixed with it, its metallic particles are more closely compacted, its texture is changed, and it is rendered more dense, soft, and malleable, tough, and difficultly fusible.

The degrees, however, of these qualities vary much in different kinds of iron. Thus some iron is tough and malleable, both when it is hot and when it is cold. This is the best and most useful iron. It may be known generally by the equable surface of the forged bar, which is free from transverse fissures or cracks in the edges, and by a clear, white, small-grained, or rather fibrous texture. Another kind is tough when it is heated, but brittle when it is cold. This is called *cold-short* iron; and is generally known by a texture consisting of large, shining plates, without any fibres. It is less liable to rust than other iron. A third kind of iron, called *red-short*, is brittle when hot, and malleable when cold. On the surface and edges of the bars of this kind of iron, transverse cracks or fissures may be seen; and its internal colour is dull and dark. It is very liable to rust. Lastly, some iron is brittle both when hot and when cold.

Most authors agree, that the red-short quality of iron proceeds from some sulphur or vitriolic acid being contained in it, because sulphur is known to produce this effect when added to iron, and because the iron obtained from pyritous and other sulphurated ores has generally this quality.

The cause of the cold-short quality of iron is not so well ascertained. Some imagine, that it proceeds from a mixture of arsenic or of antimony. But this opinion seems to be improbable, when we consider that these metallic substances may in a great measure be dissipated by roasting, whereas the ores which yield a cold-short iron are injured by much roasting; that no arsenic or antimony are observable in most, if in any, of these ores; and lastly, that these semimetals would render the iron brittle both when hot and when cold. Cramer and other authors impute this vicious quality to a mixture of unmetallic earth or vitreous matter; and affirm, that it may be destroyed by cementation with phlogiston, and by forging. And lastly, others ascribe the cold-short quality of iron to a defect of phlogiston, or, as Swedenborgius says, of sulphur. To ascertain the causes of the bad qualities of iron, and to discover practical remedies, are still desiderata in metallurgy.

In one bar frequently two or more different kinds of iron may be observed, which run all along its whole

length; and scarcely a bar is ever found of entirely pure and homogeneous iron. This difference probably proceeds from the practice we have mentioned of mixing different kinds of ores together, in the smelting; and also from the practice of mixing two or more pigs of cast iron of different qualities in the finery of these; by which means, the red-short and cold-short qualities of the different kinds are not, as we have already remarked, mutually counteracted or destroyed by each other, but each of these qualities is diminished in the mixed mass of iron, as much as this mass is larger than the part of the mass originally possessed of that quality: that is, if equal parts of red-short and of cold-short iron be mixed together, the mixed mass will be only half as red-short as the former part, and half as cold-short as the latter. For these different kinds of iron seem as if they were only capable of being interwoven and diffused through each other, but not of being intimately united or combined.

The quality of forged iron may be known by the texture which appears on breaking a bar. The best and toughest iron is that which has the most fibrous texture, and is of a clear greyish colour. This fibrous appearance is given by the resistance which the particles of the iron make to their rupture. The next best iron is that whose texture consists of clear, whitish, small grains, intermixed with fibres. These two kinds are malleable, both when hot and when cold, and have great tenacity. *Cold-short* iron is known by a texture consisting of large, shining plates, without fibres: and *red-short* iron is distinguished by its dark dull colour, and by the transverse cracks and fissures on the surface and edges of the bars. The quality of iron may be much improved by violent compression, as by forging and rolling; especially when it is not long exposed to too violent heat, which is known to injure, and at length to destroy, its metallic properties.

For the conversion of iron into *steel*, see the article STEEL.

SECT. VI. *Of the Smelting of Tin Ores.*

THE tin-ores commonly smelted are those which consist of calx of tin combined with calx of arsenic and sometimes with calx of iron. These are either pure, as the tin-grains, or intermixed with spars, stones, pyrites, ores of copper, iron, or of other metals.

The impure ores must be cleansed as much as is possible from all heterogeneous matters. This cleansing is more necessary in ores of tin than of any other metal; because in the smelting of tin-ores a less intense heat must be given than is sufficient for the scorification of earthy matters, lest the tin be calcined. Tin-ores previously bruised may be cleansed by washing, for which operation their great weight and hardness render them well adapted. If they be intermixed with very hard stones or ferruginous ores, a slight roasting will render these impure matters more friable, and consequently fitter to be separated from the tin-ores. Sometimes these operations, the roasting, contusion, and lotion, must be repeated. By roasting, the ferruginous particles are so far revived, that they may be separated by magnets.

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The ore, thus cleansed from adhering heterogeneous matters, is to be roasted in an oven or reverberatory furnace, with a fire rather intense than long continued; during which it must be frequently stirred to prevent its fusion. By this operation, the arsenic is expelled, and in some works is collected in chambers built purposely above the calcining furnace.

Lastly, the ore cleansed and roasted is to be fused, and reduced to a metallic state. In this fusion, attention must be given to the following particulars. 1. No more heat is to be applied than is sufficient for the reduction of the ore; because this metal is fusible with very little heat, and is very easily calcinable. 2. To prevent this calcination of the reduced metal, a larger quantity of charcoal is used in this than in most other fusions. 3. The scoria must be frequently removed, lest some of the tin should be involved in it; and the melted metal must be covered with charcoal powder, to prevent the calcination of its surface. 4. No flux or other substance, excepting the scoria of former smeltings which contains some tin, are to be added, to facilitate the fusion.

SECT. VII. *Smelting of Ores of Lead.*

ORES of lead are either pure, that is, containing no mixture of other metal; or they are mixed with silver, copper, or pyrites. The methods of treating ores of lead containing silver and copper, are described in the sections of *Smelting of Ores of Silver and of Copper*; and in the former of these an instance is given of the method of smelting the ore of Ramelsberg, which contains all these three metals.

Pure ores of lead, and those which contain so small a quantity only of silver as not to compensate for the expence of extracting the nobler metal, may be smelted in furnaces, and by operations similar to those used at Ramelsberg, or in the following methods. 1. From the lead-ore of Willach in Carinthia, a great part of the lead is obtained by a kind of eliquation, during the roasting of the ore. For this purpose, the ore is thrown upon several strata or layers of wood, placed in a calcining or reverberatory furnace. By kindling this wood, a great part of the lead flows out of the ore, through the layers of fuel, into a basin placed for its reception. The ore which is thus roasted is beat into smaller pieces, and exposed to a second operation similar to the former, by which more metal is eliquated; and the remaining ore is afterwards ground, washed, and smelted, in the ordinary method.

The lead of Willach is the purest of any known. Schlutter ascribes its great purity to the method used in extracting it, by which the most fusible, and consequently the purest part of the contained lead, is separated from any less fusible metal which happens to be mixed with it, and which remains in the roasted ore. This method requires a very large quantity of wood.

2. In England, lead ores are smelted either upon a hearth, or in a reverberatory furnace called a *cupel*.

In the first of these methods, charcoal is employed as fuel, and the fire is excited by bellows. Small quantities of fuel and of ore are thrown alternately

and frequently upon the hearth. The fusion is very quickly effected; and the lead flows from the hearth as fast as it is separated from the ore.

3. In the second method practised in England, pit-coal is used as fuel. The ore is melted by means of the flame passing over its surface; its sulphur is burnt and dissipated, while the metal is separated from the scoria, and collected at the bottom of the furnace. When the ore is well cleansed and pure, no addition is requisite; but when it is mixed with calcareous or earthy matrix, a kind of flour or fusible spar found in the mines is generally added to render the scoria more fluid, and thereby to assist the precipitation of the metal. When the fusion has been continued about eight hours, a passage in the side of the furnace is opened, through which the liquid lead flows into an iron cistern. But immediately before the lead is allowed to flow out of the furnace, the workmen throw upon the liquid mass a quantity of slacked quicklime, which renders the scoria so thick and tenacious, that it may be drawn out of the furnace by rakes. Schlutter mentions this addition of quicklime in the smelting of lead ores in England, but thinks that it is intended to facilitate the fusion of the ores; whereas it really has a contrary effect, and is never added till near the end of the operation, when the scoria is to be raked from the surface of the metal.

SECT. VIII. *Of the Smelting of Ores of Semi-metals.*

ANTIMONY is obtained by a kind of eliquation from the minerals containing it, as is described in the article ANTIMONY; and the regulus of antimony is procured from antimony, by the processes described in the same article, and in the article *REGULUS of Antimony*.

Arsenic, saffre, and bismuth, are obtained generally from one ore, namely, that called *cobalt*. The arsenic of the ore is separated by roasting, and adheres to the internal surface of a chimney, which is extended horizontally about 200 or 300 feet in length, and in the sides of which are several doors, by means of which the arsenic, when the operation is finished, may be swept out and collected. These chimneys are generally bent in a zig-zag direction, that they may better retard and stop the arsenical flowers. These flowers are of various colours, white, grey, red, yellow, according to the quantity of sulphur or other impurity with which they happen to be mixed. They are afterwards purified by repeated sublimations; while some alkaline or other substances are added to detain the sulphur, and to assist the purification.

In the same roasting of the ore by which the arsenic is expelled, the bismuth, or at least the greatest part of this semimetal which is contained in the ore, being very fusible, and having no disposition to unite with the regulus of cobalt, which remains in the ore, is separated by eliquation.

The remaining part of the roasted ore consists chiefly of calx of regulus of cobalt, which not being volatile, as the arsenic is, nor so easily fusible as bismuth, is, has been neither volatilized nor melted. It contains also some bismuth, and a small quantity of arsenic, together

Smelting of
Ores of Semi-metals.

Smelting of Ores of Semi-metals. together with any silver or other fixed metal which happens to be contained in the ore. This roasted ore being reduced to a fine powder, and mixed with three or four times its weight of fine sand, is the powder called *saffre* or *zaffre*. Or the roasted ore is sometimes fused with about thrice its quantity of pure sand and as much pure pot-ash, by which a blue glass, called *smalt*, is produced; and a metallic mass, called *speiss*, is collected at the bottom of the vessel in which the matters are fused. The metallic mass or *speiss* is composed of very different substances, according to the contents of the ore and the methods of treating it. The matters which it contains at different times are, nickel, regulus of cobalt, bismuth, arsenic, sulphur, copper, and silver.

See Zaffre.

See Smalt.

Bismuth is seldom procured from any other ores but that of cobalt. It might, however, be extracted from its proper ores, if a sufficient quantity of these were found, by the same method by which it is obtained from cobalt, namely, by eliquation.

Mercury, when native, and enveloped in much earthy or other matter, from which it cannot be separated merely by washing, is distilled either by ascent or by descent. When it is mineralised by sulphur, that is, when it is contained in cinnabar, some intermediate substance, as quicklime or iron, must be added in the distillation, to disengage it from the sulphur.

The rich ore of Almaden in Spain is a cinnabar, with which a calcareous stone happens to be so blended, that no addition is required to disengage the mercury from the sulphur. The distillation is there performed in a furnace consisting of two cavities, one of which is placed above another. The lower cavity is the fire-place, and contains the fuel, resting upon a

grate, through the bars of which the air enters, maintains the fire, and passes into a chimney, placed at one side of the fire-place immediately above the door through which fuel is to be introduced. The roof of this fire-place, which is vaulted and pierced with several holes, is also the floor of the upper cavity. Into this upper cavity, the mineral from which mercury is to be distilled is introduced, through a door in one of the sides of the furnace. In the opposite wall of this cavity are eight openings, all at the same height. To each of these openings is adapted a file of aludels connected and luted together, extending 60 feet in length. These aludels, which are earthen vessels open at each end, and wider in the middle than at either extremity, are supported upon an inclined terras; and the aludel of each file, that is most distant from the furnace, terminates in a chamber built of bricks, which has two doors and two chimneys.

When the upper cavity is filled sufficiently with the mineral, a fire is made below, which is continued during 12 or 14 hours. The heat is communicated through the holes of the vaulted roof of the fire-place to the mineral in the upper cavity, by which means the mercury is volatilised, and its vapour passes into the aludels, where much of it is condensed, and the rest is discharged into the brick-chamber, in which it circulates till it also is condensed. If any air or smoke passes through the aludels along with the vapour of the mercury, they escape through the two chimneys of the chamber. Three days after the operation, when the apparatus is sufficiently cooled, the aludels are unluted, the doors of the chamber are opened, and the mercury is collected.

Smelting of Ores of Semi-metals.

M E T

Metamorphosis, Metaphor.

METAMORPHOSIS, in general, denotes the changing of something into a different form; in which sense it includes the transformation of insects, as well as the mythological changes related by the ancient poets.

Mythological metamorphoses were held to be of two kinds, apparent and real: thus, that of Jupiter into a bull, was only apparent; whereas that of Lycaon into a wolf, was supposed to be real.

Most of the ancient metamorphoses include some allegorical meaning, relating either to physics or morality: some authors are even of opinion that a great part of the ancient philosophy is couched under them; and Lord Bacon and Dr Hook have attempted to unriddle several of them.

METAPHOR, in rhetoric. See ORATORY, n^o 50.

METAPHOR and Allegory, in poetry—A metaphor differs from a simile, in form only, not in substance: in a simile the two subjects are kept distinct in the expression, as well as in the thought; in a metaphor, the two subjects are kept distinct in the thought only, not in the expression. A hero resembles a lion, and upon that resemblance many similes have been raised by Homer and other poets. But instead of resembling a lion, let us take the aid of the imagination, and feign or figure the hero to be a lion: by that variation the simile is converted into a metaphor; which is carried on by

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describing all the qualities of a lion that resemble those of the hero. The fundamental pleasure here, that of resemblance, belongs to the thought. An additional pleasure arises from the expression: the poet, by figuring his hero to be a lion, goes on to describe the lion in appearance, but in reality the hero; and his description is peculiarly beautiful, by expressing the virtues and qualities of the hero in new terms, which, properly speaking, belong not to him, but to the lion. This will better be understood by examples. A family connected with a common parent, resembles a tree, the trunk and branches of which are connected with a common root: but let us suppose, that a family is figured, not barely to be like a tree, but to be a tree; and then the simile will be converted into a metaphor, in the following manner:

Edward's sev'n sons, whereof thyself art one,
Were sev'n fair branches, springing from one root;
Some of these branches by the destinies cut:
But Thomas, my dear lord, my life, my Glo'ster,
One flourishing branch of his most royal root,
Is hack'd down, and his summer-leaves all faded,
By Envy's hand and Murder's bloody axe.

Richard II. act. i. sc. 3.

Figuring human life to be a voyage at sea:

There is a tide in the affairs of men,
Which, taken at the flood, leads on to Fortune:

Metaphor.

Omitted, all the voyage of their life
Is bound in shallows and in miseries.
On such a full sea are we now afloat;
And we must take the current when it serves,
Or lose our ventures. *Julius Cæsar, act iv. sc. 5.*

Figuring glory and honour to be a garland of flowers:
Hotspur. ————— Wou'd to heav'n,
Thy name in arms were now as great as mine!
Pr. Henry. I'll make it greater ere I part from thee;
And all the budding honours on thy crest
I'll crop, to make a garland for my head.
First part of Henry IV. act v. sc. 9.

Figuring a man who hath acquired great reputation
and honour to be a tree full of fruit:

————— Oh, boys, this story
The world may read in me; my body's mark'd
With Roman swords; and my report was once
First with the best of note. *Cymbeline lov'd me;*
And when a soldier was the theme, my name
Was not far off; then was I as a tree,
Whose boughs did bend with fruit. But in one night,
A storm or robbery, call it what you will,
Shook down my mellow hangings, nay my leaves;
And left me bare to wither.
Cymbeline, act iii. sc. 3.

"Blest be thy soul, thou king of shells, said Swaran
of the dark-brown shield. In peace, thou art the gale
of spring; in war, the mountain-storm. Take now my
hand in friendship, thou noble king of Morven."

Fingal.

"Thou dwellest in the soul of Malvina, son of mighty
Offian. My sighs arise with the beam of the east: my
tears descend with the drops of night. I was a lovely
tree in thy presence, Oscar, with all my branches
round me: but thy death came like a blast from the
desert, and laid my green head low; the spring re-
turned with its showers, but no leaf of mine arose."

Fingal.

An *allegory* differs from a metaphor; and a *figure of speech* differs from both. A metaphor is
defined above to be an act of the imagination,
figuring one thing to be another. An allegory re-
quires no such operation, nor is one thing figured to
be another: it consists in choosing a subject having pro-
perties or circumstances resembling those of the prin-
cipal subject: and the former is described in such a
manner as to represent the latter: the subject thus re-
presented is kept out of view: we are left to discover
it by reflection; and we are pleased with the discovery,
because it is our own work. (See the word ALLEGORY.)
Quintilian gives the following instance of an allegory,

O navis, referent in mare te novi
Fluctus. O quid agis? fortiter occupa portum.

Horat. lib. i. ode 14.

and explains it elegantly in the following words: "Totusque ille Horatii locus, quo navim pro republica, fluctuum tempestates pro bellis civilibus, portum pro pace atque concordia, dicit."

In a *figure of speech*, there is no fiction of the ima-
gination employed, as in a metaphor; nor a represen-
tative subject introduced, as in an allegory. This fi-
gure, as its name implies, regards the expression only,
not the thought; and it may be defined, the using a

word in a sense different from what is proper to it.—Metaphor.
Thus youth, or the beginning of life, is expressed fi-
guratively by *morning of life*: morning is the beginning
of the day; and in that view it is employed to signify
the beginning of any other series, life especially, the
progress of which is reckoned by days. See *FIGURE*
of Speech.

Metaphor and *allegory* are so much connected, that
it seemed proper to handle them together: the rules
particularly for distinguishing the good from the bad,
are common to both. We shall therefore proceed to
these rules, after adding some examples to illustrate the
nature of an *allegory*, which, with a view to this ar-
ticle, was but slightly illustrated under its proper name.

Horace, speaking of his love to Pyrrha, which was
now extinguished, expresseth himself thus:

————— Me tabulâ facer
Votivâ paries indicat uvida
Suspendisse potenti
Vestimenta maris Deo. *Carm. lib. i. ode 5.*

Again:

Phœbus volentem prælia me loqui,
Victas et urbes, increpuit, lyrâ
Ne parva Tyrrenum per æquor
Vela darem. *Carm. lib. iv. ode 15.*

Queen. Great Lords, wise men ne'er sit and wail
their loss,

But cheerly seek how to redress their harms.
What though the mast be now blown overboard,
The cable broke, the holding-anchor lost,
And half our sailors swallowed in the flood!
Yet lives our pilot still. Is't meet that he
Should leave the helm, and, like a fearful lad,
With tearful eyes add water to the sea,
And give more strength to that which hath too much;
While in his moan the ship splits on the rock,
Which industry and courage might have sav'd?
Ah, what a shame! ah, what a fault were this!

Third part of Henry VI. act v. sc. 5.

Oroonoko. Ha! thou hast rous'd
The lion in his den; he stalks abroad,
And the wide forest trembles at his roar.
I find the danger now. *Oroonoko, act iii. sc. 2.*

"My well-beloved hath a vineyard in a very fruitful
hill. He fenced it, gathered out the stones thereof,
planted it with the choicest vine, built a tower in the
midst of it, and also made a wine-press therein; he
looked that it should bring forth grapes, and it brought
forth wild grapes. And now, O inhabitants of Jeru-
salem, and men of Judah, judge, I pray you, betwixt
me and my vineyard. What could have been done
more to my vineyard, that I have not done? Where-
fore, when I looked that it should bring forth grapes,
brought it forth wild grapes. And now go to, I will
tell you what I will do to my vineyard: I will take a-
way the hedge thereof, and it shall be eaten up; and
break down the wall thereof, and it shall be trodden
down. And I will lay it waste: it shall not be pruned,
nor digged, but there shall come up briars and thorns:
I will also command the clouds that they rain no rain
upon it. For the vineyard of the Lord of hosts is the
house of Israel, and the men of Judah his pleasant
plant."

Isaiah, v. 1.

The

Metaphor. The rules that govern metaphors and allegories are of two kinds. The construction of these figures comes under the first kind: the propriety or impropriety of introduction comes under the other.—To begin with rules of the first kind; some of which coincide with those already given for similes; some are peculiar to metaphors and allegories.

In the first place, it has been observed, that a simile cannot be agreeable where the resemblance is either too strong or too faint. This holds equally in metaphor and allegory; and the reason is the same in all. In the following instances, the resemblance is too faint to be agreeable.

Malcolm. ——— But there's no bottom, none,
In my voluptuousness: your wives, your daughters,
Your matrons, and your maids, could not fill up
The cistern of my lust. *Macbeth, Act iv. sc. 4.*

The best way to judge of this metaphor, is to convert it into a simile: which would be bad, because there is scarce any resemblance between lust and a cistern, or betwixt enormous lust and a large cistern.

Again:

He cannot buckle his distemper'd cause
Within the belt of rule. *Macbeth, Act v. sc. 2.*

There is no resemblance between a distempered cause and any body that can be confined within a belt.

Again:

Steep me in poverty to the very lips.
Othello, Act iv. sc. 9.

Poverty here must be conceived a fluid, which it resembles not in any manner.

Speaking to Bolingbroke banish'd for six years:

The sullen passage of thy weary steps
Esteem a foil, wherein thou art to set
The precious jewel of thy home-return.
Richard II. Act ii. sc. 6.

Again:

Here is a letter, lady,
And every word in it a gaping wound
Issuing life-blood.
Merchant of Venice, Act iii. sc. 3.

Tantæ molis erat Romanam condere gentem.
Æneid. i. 37.

The following metaphor is strained beyond all endurance: Timur-bec, known to us by the name of *Tamerlane the Great*, writes to Bajazet emperor of the Ottomans in the following terms:

“Where is the monarch who dares resist us? where is the potentate who doth not glory in being numbered among our attendants? As for thee, descended from a Turcoman sailor, since the vessel of thy unbounded ambition hath been wreck'd in the gulf of thy self-love, it would be proper, that thou shouldst take in the sails of thy temerity, and cast the anchor of repentance in the port of sincerity and justice, which is the port of safety; lest the tempest of our vengeance make thee perish in the sea of the punishment thou deservest.”

Such strained figures, as observed above, are not un-

frequent in the first dawn of refinement; the mind in a new enjoyment knows no bounds, and is generally carried to excess, till taste and experience discover the proper limits.

Secondly, whatever resemblance subjects may have, it is wrong to put one for another, where they bear no mutual proportion. Upon comparing a very high to a very low subject, the simile takes on an air of burlesque: and the same will be the effect where the one is imagined to be the other, as in a metaphor; or made to represent the other, as in an allegory.

Thirdly, These figures, a metaphor especially, ought not to be crowded with many minute circumstances; for in that case it is scarcely possible to avoid obscurity. A metaphor above all ought to be short: it is difficult, for any time, to support a lively image of a thing being what we know it is not; and for that reason, a metaphor drawn out to any length, instead of illustrating or enlivening the principal subject, becomes disagreeable by overstraining the mind. Here Cowley is extremely licentious: take the following instance.

Great and wise conqu'ror, who, where-e'er
Thou com'st, dost fortify, and settle there!
Who canst defend as well as get;
And never hadst one quarter beat up yet;
Now thou art in, thou ne'er will part
With one inch of my vanquish'd heart;
For since thou tookst it by assault from me,
'Tis garrison'd so strong with thoughts of thee,
It fears no beauteous enemy.

For the same reason, however agreeable long allegories may at first be by their novelty, they never afford any lasting pleasure: witness the *Fairy Queen*, which with great power of expression, variety of images, and melody of versification, is scarce ever read a second time.

In the fourth place, the comparison carried on in a simile, being in a metaphor sunk by imagining the principal subject to be that very thing which it only resembles; an opportunity is furnished to describe it in terms taken strictly or literally with respect to its imagined nature. This suggests another rule, That in constructing a metaphor, the writer ought to make use of such words only as are applicable literally to the imagined nature of his subject: figurative words ought carefully to be avoided; for such complicated figures, instead of setting the principal subject in a strong light, involve it in a cloud, and it is well if the reader, without rejecting by the lump, endeavour patiently to gather the plain meaning, regardless of the figures:

A stubborn and unconquerable flame
Creeps in his veins, and drinks the streams of life.
Lady Jane Gray, Act i. sc. 1.

Copied from Ovid,

Sorbent avidæ præcordia flammæ.
Metamorph. lib. ix. 172.

Let us analyse this expression. That a fever may be imagined a flame, we admit: though more than one step is necessary to come at the resemblance: a fever, by heating the body, resembles fire; and it is no stretch to imagine a fever to be a fire: again, by a figure of speech,

Metaphor. Speech, flame may be put for fire, because they are commonly conjoined; and therefore a fever may be termed a *flame*. But now admitting a fever to be a flame, its effects ought to be explained in words that agree literally to a flame. This rule is not observed here; for a flame drinks figuratively only, not properly.

King Henry to his son prince Henry:
Thou hid'st a thousand daggers in thy thoughts,
Which thou hast whetted on thy stony heart
To stab at half an hour of my frail life.

Second part Henry IV. Act iv. sc. 11.

Such faulty metaphors are pleasantly ridiculed in the *Rehearsal*:

"*Physician*. Sir, to conclude, the place you fill has more than amply exacted the talents of a wary pilot; and all these threatening storms, which, like impregnate clouds, hover o'er our heads, will, when they once are grasp'd but by the eye of reason, melt into fruitful showers of blessings on the people.

"*Bayes*. Pray mark that allegory. Is not that good?

"*Johnson*. Yes, that grasping of a storm with the eye is admirable." *Act ii. sc. 1.*

Fifthly, the jumbling different metaphors in the same sentence, beginning with one metaphor and ending with another, commonly called a *mixt metaphor*, ought never to be indulged.

K. Henry — Will you again unknit
This churlish knot of all abhorred war,
And move in that obedient orb again,
Where you did give a fair and natural light?

First part Henry VI. Act v. sc. 1.

Whether 'tis nobler in the mind, to suffer
The stings and arrows of outrageous fortune;
Or to take arms against a sea of troubles,
And by opposing end them.

Hamlet, Act iii. sc. 2.

In the sixth place, It is unpleasant to join different metaphors in the same period, even where they are preserved distinct: for when the subject is imagined to be first one thing and then another in the same period without interval, the mind is distracted by the rapid transition; and when the imagination is put on such hard duty, its images are too faint to produce any good effect:

At regina gravi jamdudum saucia cura,
Vulnus alit venis, et cæco carpitur igni.

Æneid. iv. 1.

— Est mollis flamma medullas
Interea, et tacitum vivit sub pectore vulnus.

Æneid. iv. 66.

Motum ex Metello consule civicum,
Bellique causas, et vitia, et modos,
Ludumque fortunæ, gravesque
Principum amicitias, et arma
Nondum expiatis uncta cruoribus,
Periculosa plenum opus alex,
Tractas, et incedis per ignes
Subpositos cineri doloso.

Horat. Carm. lib. ii. ode 1.

Metaphor. In the last place, It is still worse to jumble together metaphorical and natural expression, so as that the period must be understood in part metaphorically, in part literally; for the imagination cannot follow with sufficient ease changes so sudden and unprepared: a metaphor begun and not carried on, hath no beauty; and instead of light, there is nothing but obscurity and confusion. Instances of such incorrect composition are without number: we shall, for a specimen, select a few from different authors. Speaking of Britain.

This precious stone set in the sea,
Which serves it in the office of a wall,
Or as a moat defensive to a house
Against the envy of less happier lands.

Richard II. act ii. sc. 1.

In the first line Britain is figured to be a precious stone: in the following line, Britain, divested of her metaphorical dress, is presented to the reader in her natural appearance.

These growing feathers pluck'd from Cæsar's wing,
Will make him fly an ordinary pitch
Who else would soar above the view of men,
And keep us all in servile fearfulness.

Julius Cæsar, act i. sc. 1.

Rebus angustis animosus atque
Fortis adpare: sapienter idem
Contraheas vento nimium secu
Turgida vela.

Hor.

The following is a miserable jumble of expressions, arising from an unsteady view of the subject, between its figurative and natural appearance:

But now from gath'ring clouds destruction pours,
Which ruins with mad rage our halcyon hours:
Mists from black jealousies the tempest form,
Whilst late divisions reinforce the storm.

Dispensary, canto iii.

To thee the world its present homage pays,
The harvest early, but mature the praise.

Pope's imitation of Horace, B. ii.

Oui, sa pudeur ne'st que franche grimace,
Qu'une ombre de vertu qui garde mal la place,
Et qui s'évanouit, comme l'on peut savoir,
Aux rayons du soleil qu'une bourse vait voir.

Moliere, L'Etourdi, act iii. sc. 2.

Et son feu, de pourvu de sence et de lecture,
S'éteint à chaque pas, faut de nourriture.

Boileau, L'art poetique, chant. iii. l. 319.

Dryden, in his dedication of the translation of *Juvenal*, says, "When thus, as I may say, before the use of the loadstone, or knowledge of the compass, I was sailing in a vast ocean, without other help than the pole-star of the ancients, and the rules of the French stage among the moderns, &c."

"There is a time when factions, by the vehemence of their own fermentation, stun and disable one another."

Bolingbroke.

This fault of jumbling the figure and plain expression into one confused mass, is not less common in allegory than in metaphor.

Take

Metaphor. Take the following examples :

Heu! quoties fidem,
Mutatosque Deos flebit, et aspera
Nigris æquora ventis
Emirabitur insolens,
Qui nunc te fruitur credulus aureâ :
Qui semper vacuum, semper amabilem
Sperat, nescius auræ
Fallacis. *Horat. Carm. lib. i. ode 5.*

Pour moi sur cette mer, qu'ici bas nous courons,
Je songe à me pourvoir d'esquif et d'avirons,
A régler mes desirs, à prévenir l'orage,
Et sauver, s'il se peut, ma Raison du naufrage.
Boileau, épître 5.

Lord Halifax, speaking of the ancient fabulists :
" They (says he) wrote in signs, and spoke in parables : all their fables carry a double meaning : the story is one, and entire ; the characters the same throughout ; not broken or changed, and always conformable to the nature of the creature they introduce. They never tell you, that the dog which snapp'd at a shadow, lost his troop of horse ; that would be unintelligible. This is his (Dryden's) new way of telling a story, and confounding the moral and the fable together." After instancing from the hind and panther, he goes on thus : " What relation has the hind to our Saviour ? or what notion have we of a panther's Bible ? If you say he means the church, how does the church feed on lawns, or range in the forest ? Let it be always a church, or always a cloven-footed beast ; for we cannot bear his shifting the scene every line."

A few words more upon allegory. Nothing gives greater pleasure than this figure, when the representative subject bears a strong analogy, in all its circumstances, to that which is represented : but the choice is seldom so lucky ; the analogy being generally so faint and obscure, as to puzzle and not please. An allegory is still more difficult in painting than in poetry : the former can show no resemblance but what appears to the eye ; the latter hath many other resources for showing the resemblance. And therefore, with respect to what the Abbé du Bos terms *mixt allegorical compositions*, these may do in poetry ; because, in writing, the allegory can easily be distinguished from the historical part : no person, for example, mistakes Virgil's Fame for a real being. But such a mixture in a picture is intolerable ; because in a picture the objects must appear all of the same kind, wholly real or wholly emblematical. For this reason, the history of Mary de Medicis, in the palace of Luxembourg, painted by Rubens, is unpleasant by a perpetual jumble of real and allegorical personages, which produce a discordance of parts, and an obscurity upon the whole : witness, in particular, the tablature representing the arrival of Mary de Medicis at Marseilles ; where, together with the real personages, the Nereids and Tritons appear founding their shells : such a mixture of fiction and reality in the same group, is strangely absurd. The picture of Alexander and Roxana, described by Lucian, is gay and fanciful ; but it suffers by the allegorical figures. It is not in the wit of man to invent an allegorical representation deviating farther from any shadow of resemblance, than one exhibited by Louis XIV. anno 1664 ; in which an enormous chariot, intended to represent

that of the sun, is dragged along, surrounded with men and women, representing the four ages of the world, the celestial signs, the seasons, the hours, &c. a monstrous composition, and yet scarce more absurd than Guido's tablature of Aurora.

In an allegory, as well as in a metaphor, terms ought to be chosen that properly and literally are applicable to the representative subject : nor ought any circumstance to be added that is not proper to the representative subject, however justly it may be applicable properly or figuratively to the principal. The following allegory is therefore faulty :

Ferus et Cupido,
Semper ardentes acuens sagittas
Cote cruentâ. *Horat. lib. ii. ode 8.*

For though blood may suggest the cruelty of love, it is an improper or immaterial circumstance in the representative subject : water, not blood, is proper for a whetstone.

We proceed to the next head, which is, to examine in what circumstances these figures are proper, in what improper. This inquiry is not altogether superseded by what is said upon the same subject in the article COMPARISON ; because, upon trial, it will be found, that a short metaphor or allegory may be proper, where a simile, drawn out to a greater length, and in its nature more solemn, would scarce be relished.

And, in the first place, a metaphor, like a simile, is excluded from common conversation, and from the description of ordinary incidents. Second, in expressing any severe passion that totally occupies the mind, metaphor is unnatural.

The following example, of deep despair, beside the highly figurative style, has more the air of raving than of sense :

Calista. Is it the voice of thunder, or my father ?
Madness ! confusion ! let the storm come on,
Let the tumultuous roar drive all upon me,
Dash my devoted bark ; ye surges, break it ;
'Tis for my ruin that the tempest rises.
When I am lost, sunk to the bottom low,
Peace shall return, and all be calm again.

Fair Penitent, act 5.

The following metaphor is sweet and lively ; but it suits not the fiery temper of Chamont, inflamed with passion : parables are not the language of wrath venting itself without restraint :

Chamont. You took her up a little tender flow'r,
Just sprouted on a bank, which the next frost
Had nipp'd ; and with a careful loving hand,
Transplanted her into your own fair garden,
Where the sun always shines : there long she flourish'd,
Grew sweet to sense, and lovely to the eye ;
Till at the last a cruel spoiler came,
Cropt this fair rose, and rifled all its sweetness,
Then cast it like a loathsome weed away. *Orph. act 4.*

The following speech, full of imagery, is not natural in grief and dejection of mind.

Gonzalez. O my son ! from the blind dotage
Of a father's fondness these ills arose.
For thee I've been ambitious, base, and bloody :

For

Metaphor. For thee I've plung'd into this sea of sin;
Stemming the tide with only one weak hand,
While t'other bore the crown (to wreath thy brow),
Whose weight has sunk me ere I reach'd the shore.

Mourning Bride, act 5. sc. 6.

There is an enchanting picture of deep distress in Macbeth, where Macduff is represented lamenting his wife and children, inhumanly murdered by the tyrant. Stung to the heart with the news, he questions the messenger over and over: not that he doubted the fact, but that his heart revolted against so cruel a misfortune. After struggling some time with his grief, he turns from his wife and children to their savage butcher: and then gives vent to his resentment, but still with manliness and dignity:

O, I could play the woman with mine eyes,
And braggart with my tongue. But, gentle Heav'n!
Cut short all intermission; front to front
Bring thou this fiend of Scotland and myself;
Within my sword's length set him.— If he 'scape,
Then Heav'n forgive him too.

Metaphorical expression, indeed, may sometimes be

used with grace where a regular simile would be intolerable: but there are situations so severe and dispiriting, as not to admit even the slightest metaphor. It requires great delicacy of taste to determine with firmness, whether the present case be of that nature: perhaps it is; yet who could wish a single word of this admirable scene altered?

But metaphorical language is proper when a man struggles to bear with dignity or decency a misfortune however great; the struggle agitates and animates the mind:

Wolfey. Farewell, a long farewell, to all my greatness!
This is the state of man: to-day he puts forth
The tender leaves of hope; to-morrow blossoms,
And bears his blushing honours thick upon him;
The third day comes a frost, a killing frost,
And when he thinks, good easy man, full surely
His greatness is a ripening, nips his root,
And then he falls as I do. *Henry VIII. act 3. sc. 6.*

METAPHRAST, a translator, or person who renders an author into another form or another language, word for word.

M E T A P H Y S I C S.

Definition. METAPHYSICS has been defined, by a writer deeply read in the ancient philosophy, "The science of the principles and causes of all things existing." This definition, we think, extremely proper: and hence it is, that *mind* or intelligence, and especially the *supreme intelligence*, which is the cause of the universe and of every thing which it contains, is the principal subject of this science; and hence, too, the science itself received its name. Aristotle, indeed, who, of all the ancient metaphysicians whose works have come down to us, was unquestionably the greatest, calls this science THE FIRST PHILOSOPHY, as being not only superior, but also prior in the order of nature, to the whole circle of the other arts and sciences. But, "what is first to nature, is not first to man." Nature begins with *causes* which produce *effects*. Man begins with *effects*, and by them ascends to *causes*. Thus all human study and investigation proceed of necessity in the reverse of the natural order of things, from *sensible* to *intelligible*, from *body* the effect, to *mind*, which is both the first and the final cause. Now, PHYSICS being the name given by the Stagyrice to the philosophy of body, some of his interpreters, from this necessary course of human studies, called that of mind METAPHYSICS, implying by that term, not only that its subject is more sublime and difficult, but also that the study of it would be most properly and successfully entered upon AFTER THAT OF PHYSICS. To this name, which, though it has sometimes been treated with ridicule, is abundantly

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significant, the followers of Aristotle were led by their master, who, to the books in which he pretends to elevate the mind above things corporeal to the contemplation of God and things spiritual, prefixed the Greek words *meta ta physika* (A).

The science of Metaphysics has been divided, according to the objects which it considers, into six principal parts, which are called, 1. *Ontology*; 2. *Cosmology*; 3. *Anthroposophy*; 4. *Psychology*; 5. *Pneumatology*; and, 6. *Metaphysical theology*.

1. That part of the science which is named *ontology*, investigates and explains the nature and essence of all beings, as well as the qualities and attributes that essentially appertain to them. Hence it has been said that ontology should proceed in its operations from the most simple ideas; such as do not admit of any other qualities of which they may be compounded. These simple ideas are of *being*, of *essence*, of *substance*, of *mode*, of *existence* as well with regard to time as place, of a *necessary cause* of *unity*; the idea of *negation*; the difference between a *being* that is *simple* or *compound*, *necessary* or *accidental*, *finite* or *infinite*; the ideas of *essential* and *abstract properties*, such as of the *greatness*, *perfection*, and *goodness* of *beings*, &c. The business therefore of ontology, is to make us acquainted with every kind of being in its nature and essential qualities, which distinguish it from all other beings. This knowledge being once established on simple principles, just consequences may thence be drawn, and those things proved after which the metaphysician enquires,

(A) ΤΩΝ ΜΕΤΑ ΤΑ ΦΥΣΙΚΑ. Cujus inscriptionis hæc ratio est, quod in hoc opere ea tractantur quorum theoria posterior est doctrina naturali saltem quoad nos, qui a corporum cognitione rerumque caducarum in substantiarum immaterialium atque immortalium contemplationem provehimur.

Du Val. Synops. Doctr. Peripat.

Divisions of quires, and which is the business of his science to the Science prove.

It is easy to conceive, that even a clear knowledge of beings, and their essential properties, would be still defective and useless to man, if he did not know how to determine and fix his ideas by proper denominations, and consequently to communicate his perceptions to those whom he would instruct, or against whom he is obliged to dispute. To render our ideas therefore intelligible to others, we must have determinate words or denominations for each being, and the qualities of each being; and ontology teaches us those terms which are so necessary to fix our ideas, and to give them the requisite perspicuity and precision, that when we endeavour to extend the sphere of our knowledge, we may not waste our time in disputes about words.

4 Cosmology; 2. Metaphysics, having, in as solid a manner as possible, explained and established the principles above mentioned, continues its enquiries to the second part, which is called *cosmology*, and examines into the essence of the world and all that it contains, its eternal laws; of the nature of matter; of motion; of the nature of tangible bodies, their attributes and adjuncts; and of all that can be known by reasoning and experience. It is also in cosmology that the metaphysicians of this school examine the Leibnitzian system; that is, whether God, in creating the world, must necessarily have created the best world; and if this world be so in fact. In this manner they pursue the argument, from consequence to consequence, to its last resort, frequently with very little advantage to truth and science.

5 Anthropolophy; 3. *Anthropolophy*, or the knowledge of man, forms the third branch of metaphysics. It is subdivided into two parts. The first, which consists in the knowledge of the exterior parts of the human frame, belongs not to this science, but to Anatomy and Physiology. The business of the metaphysician is here to ascertain the nature of those powers by which all the motions essential to life are produced; and to discover, if possible, whether they be corporeal or spiritual. This inquiry leads at the same time to

6 Psychology; 4. *Psychology*; which consists in the knowledge of the intellectual soul in particular: concerning which, the most profound, the most subtle, and most abstract researches, have been made that human reason is capable of; and concerning the substance of which, in spite of all these efforts, it is yet extremely difficult to support any positive opinion with conclusive or probable arguments.

7 Pneumatology; 5. The fifth part of metaphysics is called *pneumatology*. By this term, which has not been long in use, metaphysicians mean the knowledge of all spirits, *angels*, &c. It is easy to conceive what infinite art is necessary to give an account of that, of which nothing positive can ever be known in the present state of human existence. But the metaphysician of this school readily offers to show us, "what is the idea of a spirit; the effective existence of a spirit; what are its general qualities and properties; that there are rational spirits, and that these rational spirits have qualities that are founded in the moral attributes of God:" for this is in so many words what is attempted to be taught in *pneumatology*.

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6. *Metaphysical theology*, which Leibnitz and some others call *theodicy*, is the sixth and last branch of the science of metaphysics. It teaches us the knowledge of the existence of God; to make the most rational suppositions concerning his divine essence, and to form a just idea of his attributes and perfections, and to demonstrate them by abstract reasoning. Theodicy differs from natural theology, in as much as this last borrows, in fact, from theodicy proofs and demonstrations to confirm the existence of a supreme Being: but after having solidly established that great truth, by extending its consequences natural theology teaches us what are the relations and connections that subsist between the supreme Being and men, and what are the duties which result from those relations.

We have briefly mentioned these divisions of the science, because they were once prevalent in the schools. The greater part of them, however, appears to us to be not only superfluous, but such as can serve no other purpose than to perplex the mind. The only beings of which we know any thing are mind and body; and we have no reason to think that there are any other beings in the universe. Of bodies indeed there are various kinds, endowed with different properties: and it is extremely probable, that of minds endowed with different powers, the variety may be equally great. Our own minds we know to be united in one system with bodies by which they perform all their operations; and we can demonstrate that there is another Mind, which is independent of all body, and is the cause of all things. Between these there may be numberless orders of minds; but their energies are wholly unknown to us, and therefore they can never become the objects of science.

Mind and body therefore, *i. e.* the minds and bodies which we know to exist, together with their powers and properties, essential and accidental, can alone be the subjects of rational inquiry. We may inquire into the essence of mind and the essence of body, and endeavour to ascertain in what respects they differ. We may examine the nature of different bodies, in order to discover whether all bodies, however modified, have not something in common; and we may consider the properties, relations, and adjuncts of bodies, and endeavour to distinguish those which are accidental from such as appear to be so necessary that without them body itself could not exist. Of minds we cannot make the same comparison. In this part of the science we have not sufficient data for an accurate and complete induction: we can only examine the powers of our own mind; and by probable analogy make some estimate of the powers of superior minds, as observation will help us to guess at the powers of those which are placed beneath us in the scale of existence.

If this be so, Cosmology, as distinguished from Ontology, cannot properly be a branch of Metaphysics. For if mind and body, with their several powers, properties, and adjuncts, compose the universe, it is obvious, that when we have ascertained, as well as we are able to ascertain, the essence of mind and the essence of body, together with the powers and properties of each, and have traced them all to the first cause, we have done every thing in the science of the universe, if we may use the expression, which belongs

Divisions of the Science
8 Metaphysical theology.

9 This division useless and improper.

Divisions of
the Science

to the province of the metaphysician. The particular laws of motion on the earth and in the planetary system belong to the natural philosopher and astronomer.

In like manner, Anthroposophy, Psychology, and Pneumatology, if they be not words expressive of distinctions where there is no difference, seem to be at least very needlessly disjoined from each other. Of the nature of spirits we can know nothing but from contemplating the powers of our own minds; and the body of man is in the province, not of the metaphysician, but of the anatomist and physiologist. Anthroposophy, psychology, and pneumatology, if they be used to denote our knowledge of all minds except the Supreme, are words of the same import; for of no created minds except our own can we acquire such knowledge as deserves the name of science.

Ontology has sometimes been defined the science of *being in the abstract*; but in the course of our inquiries it will be seen, that *being in the abstract* is a phrase without meaning. Considered as the science of *real beings* and their *properties*, Ontology is a very significant word, of the same import with Metaphysics, comprehending in itself the knowledge of the nature of all things existing. Or if it be thought proper to make a distinction between ontology and theology, the former branch of the science will teach the knowledge of body and created minds, whilst it is the province of the latter to demonstrate the existence and attributes of that mind which is uncreated.

10
Another
proposed.

Body and mind therefore, with their properties, adjuncts, and powers, comprehend the whole subject of the science of metaphysics: and as we are earlier acquainted with body than with mind, the natural order of conducting our inquiries seems to be, to begin with the former, and thence proceed to the latter. It is however obvious, that if we would pursue these inquiries with any hopes of success, we must first trace human knowledge from its source, ascertain the nature of truth, and show what kind of evidence on each topic to be treated ought to enforce conviction. In this view of the science, metaphysics appears to be divided into three parts; the first treating of *human understanding*; the second, of *body with its adjuncts*; and the third, of *mind with its powers*.

11
Idea and
notion ex-
plained.

Previous to the entering upon such inquiries, some philosophers of great merit have lately thought it expedient to explain the terms which they should have

occasion to use. Their conduct is judicious and worthy of imitation; for the objects of metaphysics being, for the most part, such as fall not under the cognisance of the senses, are liable to be differently apprehended by different men, if the meanings of the words by which they are expressed be not ascertained with the utmost precision. We intend, however, to use very few words but in the common acceptation; and we therefore hope, that as terms of science are explained under different words in the Dictionary, to which references are made, we have little or no occasion for swelling the article by previous definitions. There are indeed two words which have given rise to much useless disputation, which yet cannot be banished from speculative philosophy, and which it will therefore be proper here to define. The words to which we allude are *idea* and *notion*. These are very generally considered as synonymous; but we think that much loquacity might have been avoided by assigning to each a determinate signification. We know not any philosopher who made much use of the word *idea* before Plato; but with his mysterious doctrine concerning ideas we have here nothing to do: our present business is to ascertain the precise meaning of the word, which is evidently derived from *idea* to *see*, as the word *notion* is from "nosco, novi, notum," and that from *γινωσκω*, to *know* or *understand*. In the original sense of the two words, therefore, *notion* is more comprehensive than *idea*, because we *know* many things which cannot be *seen*. We have not a doubt, but that at first the word *idea* was employed to denote only those forms of external objects which men contemplate in their imaginations, and which are originally received through the sense of *sight*. Its signification was afterwards extended to the relics of every sensation, of touch, taste, sound, and smell, as well as of sight; and at last it was confounded with *notion*, which denotes the mental apprehension of whatever may be known. In our use of the word *idea*, except when we quote from others, we shall employ it only to denote that appearance which absent objects of sense make in the memory or imagination (A); and by the word *notion* we shall denote our apprehension or knowledge of spirits, and all such things as, though they be the objects of science, cannot be perceived by the external senses. Having said this, we proceed to our inquiries, beginning with that into human understanding.

Divisions of
the Science

(A) In thus restricting the meaning of the word *idea*, we have the honour to agree with the great English Lexicographer.—"He was particularly indignant against the almost universal use of the word *idea* in the sense of *notion* or *opinion*, when it is clear that *idea* can only signify something of which an image may be formed in the mind. We may have an *idea* or *image* of a mountain, a tree, or a building; but we cannot surely have an *idea* or *image* of an argument or proposition. Yet we hear the sages of the law delivering their *ideas* upon the question under consideration; and the first speakers in parliament entirely coinciding in the *idea*, which has been so ably stated by an honourable member; or representing an *idea* as unconstitutional, and fraught with the most dangerous consequences to a great and free country. This Johnson called *modern cant*." *Boswell's Life of Johnson*.

PART

*Preliminary Observations on the ORIGIN of our IDEAS
and NOTIONS.*

12
No innate
ideas or no-
tions in the
human
mind.

THAT the mind of man has no innate ideas or notions, but comes into the world ignorant of every thing, is a truth which since the days of Locke has been very little disputed. In the first book of his Essay on the Human Understanding, that acute philosopher has demonstrated, that the rudiments or first principles of all our knowledge are communicated to us by sensation; and he has compared the mind, previous to the operation of external objects upon the senses, to a *tabula rasa* or sheet of white paper. To repeat his arguments would swell the article to no purpose. There is not a man capable of attending to his own ideas, who can entertain a doubt in what manner he received them. Without the sense of sight, we could never have known colours; nor sound, without hearing; nor hardness, softness, smoothness, pain, or bodily pleasure, without touch; nor odours, without smell, &c.

* Essay on
the Nature
and Immuta-
bility of
Truth.

Self-evident as these facts are, objections have been started to the inferences drawn from them; and Locke has been accused of advancing principles subversive of all distinction between truth and falsehood, and favourable of course to universal scepticism.—“The first book of his Essay, which with submission (says Dr Beattie*) I think the worst, tends to establish this dangerous doctrine, that the human mind, previous to education and habit, is as susceptible of one impression as of another: a doctrine which, if true, would go near to prove that truth and virtue are no better than human contrivances; or at least that they have nothing permanent in their nature, but may be as changeable as the inclinations and capacities of men; and that there is no such thing as common sense in the world. Surely this is not the doctrine which Mr Locke meant to establish.” We are so thoroughly satisfied that it is not, that we cannot help wondering how such inferences could, by a man of learning, genius, and candour, be drawn from any thing which is to be found in the Essay on the Human Understanding.

† J. Usher,
author of
Clio. See a
vol. of Fug-
itive Pieces
printed for
J. Davies,
London,
1774.

But the Doctor thinks Mr Locke’s “simile of the mind to white paper one of the most unlucky allusions that could have been chosen; because the human soul, when it begins to think, is not extended, nor of a white colour, nor incapable of energy, nor wholly unfurnished with ideas, nor as susceptible of one impression or character as of any other:” and it has been observed by another objector†, that “on a sheet of white paper you may write that sugar is bitter; wormwood sweet; fire and frost in every degree pleasing and sufferable; that compassion and gratitude are base; treachery, falsehood, and envy, noble; and that contempt is indifferent to us.”

13
Objections
answered.

All this is true; but we apprehend it is not to the purpose. Mr Locke has no where expressed himself in such a manner as to lead us to suppose that he believed the soul to be extended or coloured; or, when it begins to think, incapable of energy, and wholly unfurnished with ideas: but he certainly did believe, that it begins not to think the first instant of its existence,

and that it *acquires* all the ideas of which it is ever possessed. We may undoubtedly write upon a piece of white paper that sugar is bitter, and that wormwood is sweet; but how the capacity of paper to receive the symbols of false propositions should make Mr Locke’s comparison improper or dangerous, we cannot comprehend. Mr Usher indeed says, that it is improper on this account, “that no human art or industry is able to make those impressions upon the mind: in respect of them, the mind discovers not a passive capacity, but resists them with the force of fate.” Does it indeed? does the mind reject the idea of sugar or of bitterness, of contempt or of indifference? May not any man have the *idea* of sugar and at the same time the *idea* of bitterness, and compare the one with the other in his mind, as well as the word *sugar* may be written beside the word *bitter*, and connected with it on the same piece of paper? In all this we perceive nothing that is impossible or even difficult. The mind cannot indeed be made to feel that sugar has the same taste with wormwood; but who ever thought that it could? Not Mr Locke, we shall be bold to say; nor does his simile give the smallest countenance to such an absurdity. The author of the Essay on the Human Understanding understood his subject too well to imagine that either truth or falsehood could be communicated to paper, or that paper is capable of comparing ideas. Paper is capable of receiving nothing but lines or figures; and it passively receives whatever lines or figures we may choose to inscribe on it: yet if a pen be carried over it in a circular direction, the figure impressed will not be a square; just as, to the mind of one eating sugar, the taste communicated is not that of wormwood.

On a piece of paper a circle may be described, and close beside it a square: in like manner an agreeable sensation may be communicated to the mind, and immediately afterwards a sensation that is disagreeable. These two sensations, or the ideas which they leave behind them, may be compared together; and it is certainly true that no art or industry can make them appear similar in the mind: but is it not equally true, that no art or industry can make the circle and the square similar on the paper? The paper is susceptible of any sort of plain figures, and the mind is equally susceptible of any sort of ideas or sensations; but figures dissimilar cannot be made to coincide, neither can discordant ideas be made to agree. Again, one may write upon paper, that “a circle is a square,” and likewise that “a circle is not a square;” and both these propositions may be communicated to the mind by the organs of sight or of hearing. The paper receives the *words* expressive of the false as well as those expressive of the true proposition; and the mind receives the *ideas* and *relations* signified by the one cluster of words as well as those signified by the other: but in the mind the *idea* of a square is *different* from that of a circle, and on the paper the *figure* of a square is *different* from the *figure* of a circle. The great difference between the mind and the paper is, that the *former* is *conscious* of its ideas, and *perceives* their agreement or disagreement; whereas the paper is *not* conscious of

Origin of
Ideas and
Notions.

the figures drawn upon it, nor perceives any thing about them. But still those figures are what they are; they either agree or disagree on the paper, as well as the ideas either agree or disagree in the mind. It is not in the power of the mind to alter the *ideas* of the square and the circle, nor in the power of the paper to alter the *forms* of these figures.

It appears then, that the principles of Mr Locke, and the comparison by which he illustrates them, have no more tendency to subvert the difference between truth and falsehood, right and wrong, than the passiveness of paper has to subvert the difference between a straight line and a crooked, a circle and a square: and with a view to establish the doctrine of innate ideas and instinctive principles of knowledge, we might with as much propriety ask, Whether it be possible to imagine that any mode of manufacture could make paper of such a nature, as that a pen drawn over it in a circular direction would leave the figure of a square? as that, "Whether it be possible to imagine, that any course of education could ever bring a rational creature to believe that two and two are equal to three?"

14
But all derived from
sensation
and reflection.

The mind being thus, as we may say, originally white paper, void of all characters, without ideas or notions of any kind, the first question which we have to consider is, Whence and in what manner it derives the materials of all its knowledge? To this question the only answer which can be given is, That it derives them from observation and experience; from observation, either employed upon external objects of sense, or turned inwardly upon its own operations. Our senses, conversant about particular external objects, convey into the mind several distinct perceptions; such as those of *colour, figure, heat, cold, bitterness, sweetness*, and all those things which are usually called *sensible qualities*. The notions, ideas, or whatever else they may be called, which are acquired in this manner, may be called *sensible knowledge*; and the source of that knowledge is termed *sensation*.

The other fountain from which experience furnishes the understanding with knowledge, is that attention which we are capable of giving to the operations of our own minds when employed about those ideas which were originally suggested by objects of sense. These operations, when the soul comes to reflect on them, furnish us with a set of notions entirely different from the ideas of sense; such as the notions of *perception, thinking, doubting, believing, reasoning, knowing, willing*, and all the different energies and passions of our own minds. Of these operations we are always conscious when we are awake: but it requires, as shall be shown afterwards, no inconsiderable effort to set them, as it were, at a distance, to reflect on them and consider what they are; but when we have made this effort, we acquire notions as distinct, and perhaps more important, than those ideas which we receive by the medium of the senses.

Sensation and reflection then furnish mankind with the first materials of all their knowledge. The mind seems not to have ideas or notions of any kind which it did not receive by one of these ways. By means of the senses it perceives external objects; and by that power which it has of turning its attention upon itself, it discovers the nature and manner of its own operations.

Although the knowledge which we acquire from *reflection* be of equal importance, and perhaps of greater certainty than that which we receive through the medium of the senses, it comes into the mind at a much later period; both because it is impossible that the faculties of the mind should operate without materials, and because it is much more difficult to attend to these operations even while they are going on, than to the objects of sense which solicit our attention. It is for this reason pretty late before children have any notions whatever of the operations of their own minds; and of the greater part of these operations the bulk of mankind have no clear or accurate notions during their whole lives. On the other hand, every human being is so surrounded with bodies, which perpetually and variously affect his senses, that a variety of sensible ideas force an entrance even into the minds of children. In order therefore to trace the procedure of the understanding, and to ascertain the extent and limits of human knowledge, it should seem that we must begin with considering the external senses, that we may discover the manner in which we receive knowledge by means of them, the objects of that knowledge, and its certainty. It is to be observed, however, that though we consider the mind as possessed of many powers or faculties, and inquire first into the nature of that faculty which we conceive to be first exerted, this is done merely for the sake of proceeding in our subject with method and perspicuity. The mind is one simple and undivided being; and in every mental energy it is the whole mind, and not any part or portion of it, that is energetic. On this account, it is impossible to explain even the nature of sensation and perception to him who knows not what is meant by *will* and *understanding*; but to every one who is acquainted with the common import of these words, and who has read the short system of *Logic* inserted in this Work, we hope that our theory of perception will be intelligible and convincing.

Origin of
Ideas and
Notions.

CHAP. I. Of SENSATION and PERCEPTION.

SECT. I. Of Sensation.

THE Supreme Being, who made us and placed us in this world, has given us such powers of mind as he saw to be suited to our state and rank in his creation. He has given us the power of perceiving many objects around us: but that power is limited in various ways; and particularly in this, that without the organs of the several senses we perceive no external object. The senses, as every one knows, are five in number, and each communicates its proper sensation. It is by the eyes alone that we see, by the ears that we hear, by the nose that we smell, and by the tongue and palate that we taste; the sense of feeling or touch is spread over the whole body, for we feel equally by our hands and by our feet, &c. To the powers of perception by the senses it is necessary not only that we have all the organs enumerated, but that we have them also in a sound and natural state. There are many disorders of the eye which cause total blindness, as well as others which impair without destroying the power of vision. The same thing is true of the organs of all the other senses.

All this is so well known from experience, that it needs no proof; but it may be worth while to observe, that

15
Sensation
by five
organs.

Of Sensation.

† Reid's Essay on the Intellectual Powers of Man.

16 These organs themselves not sentient, but

17 Instruments of sensation.

* Elements of Criticism.

Of Sensation.

Reid's Essay on the Intellectual Powers of Man, and Hartley's Observations on Man.

18 The brain and nerves necessary to sensation.

19

Process of nature in sensation.

6

course

that it is known from experience only†. For any thing that we know to the contrary, our Creator might have endowed us with the power of perception by a thousand organs of sense, all different from those which we possess; and it is certain that he himself perceives every thing more perfectly than we do without bodily organs. For it is to be observed, that the organs of sense are different from the being which is sentient.— It is not the eye which sees, nor the ear which hears; these are only the organs by which we see and hear. A man cannot see the satellites of Jupiter but by means of a telescope, nor hear a low voice but by means of an ear-trumpet. Does he from this conclude, that it is the telescope which sees those satellites, or the trumpet which hears that voice? Such a conclusion would be evidently absurd. It is no less absurd to conclude that it is the eye which sees, or the ear which hears. The telescope and the trumpet are artificial organs of sight and of hearing, of which the eye and the ear are natural organs; but the natural organs see and hear as little as the artificial.

That this is the case with respect to the eye and the ear, is so obvious, that, as far as we know, it has never been denied. But with respect to the senses of touch, taste, and smell, the truth at first view appears not so evident. A celebrated writer has observed*, that “after the utmost efforts, we find it beyond our power to conceive the flavour of a rose to exist in the mind: we are necessarily led to conceive that pleasure as existing in the nostrils, along with the impression made by the rose upon that organ (c); and the same will be the result of experiments with respect to every feeling of taste, touch, and smell. Touch (he says), affords the most satisfactory evidence, and philosophy detects the delusion.” To detect this delusion requires, indeed, no great depth in philosophy; for it is so far from being true that we are necessarily led otherwise than by association, of which the laws shall be explained afterwards, to conceive the pleasure or pain of touch as existing at that part of our body upon which the impression is made, that, as every man must have observed, children previous to experience cannot distinguish the precise place of their bodies which is affected by the touch of any external object. Nay, we believe it will be found upon trial, that if a full grown man, with all the experience of age to guide him, be pricked with a pin on any part of his body which he has seldom handled, and never seen, he will not readily nor at first put his finger upon the wound, nor even come very near to the wound. This, however, he would certainly and infallibly do were the sense of touch necessarily conceived as existing at the organ. To these observations objections may perhaps be made, which we cannot stay to obviate; but the following, we think, will admit of none. We appeal to every man who has

experienced that particular sensation of touch which Scaliger dignified with the name of a sixth sense, whether, whilst those sensations were new to him, he was necessarily led to conceive them as existing at any particular organ. If he was not, it follows undeniably that the organs of sensation are different from the being which is sentient; that it is not the eye which sees, the ear which hears, the nostrils which smell, the tongue which tastes, nor any part of the body which feels; and that it is by experience that we learn to associate our several sensations with those organs upon which the impressions are made.

It is, however, certain that we receive no sensation from external objects, unless when some impression is made upon the organ of sense, either by the immediate application of the object itself, or by some medium which passes between the object and the organ†. In two of our senses, viz. touch and taste, there must be an immediate application of the object to the organ. In the other three the sensation is occasioned by the impression of some medium passing from the object to the organ. The effluvia of bodies drawn into the nostrils with the breath are the medium of smell; the undulations of the air are the medium of hearing; and the rays of light passing from visible objects to the eye are the medium of sight. These are facts known from experience to hold universally both in men and in brutes. It is likewise a law of our nature perfectly known to all who know any thing of anatomy, that in order to actual sensation the impressions made upon the external organs must be communicated to the nerves, and from them to the brain. First, the object, either immediately, or by some medium, makes an impression upon the organ; the organ serves only as a medium, by which the impression is communicated to the nerves; and the nerves serve as a medium to carry it on to the brain. Here the corporeal part ends; at least we can trace it no farther. The rest is all intellectual.

The proof of these impressions upon the nerves and brain in sensation is this, that from many observations and experiments it is found, that when the organ of any sense is perfectly sound, and has the impression made upon it by the object ever so strongly, yet if the nerve which serves that organ be cut or tied hard, there is no sensation; and it is well known that disorders in the brain deprive us of sensation, while both the organ and its nerve are sound.

There is sufficient reason, therefore, to conclude, that in sensation the object produces some change in the organ; that from the organ the change proceeds to the nerve, and from the nerve to the brain. Hence it is that we have positive sensations from negative objects, or mere non-entities, such as darkness, blackness, and vacuity. For, sensation resulting from changes in the brain, whatever produces any change must of

(c) Another eminent writer thinks on this subject very differently, and in our opinion much more justly.— “Suppose (says Dr Reid) a person who never had this sense (viz. smell) before, to receive it all at once, and to smell a rose; can he perceive any similitude or agreement between the smell and the rose? or indeed between it and any other object whatever? Certainly he cannot. He finds himself affected in a new way, he knows not why, or from what cause. He is conscious that he is not the cause of it himself; but he cannot from the nature of the thing determine whether it be caused by body or spirit; by something near, or by something at a distance. He cannot give it a place any more than he can give a place to melancholy or joy; nor can he conceive it to have any existence but when it is smelled.”

Inquiry into the Human Mind, ch. 2. sect. 2.

Of Sensa-
tion.

course occasion a new sensation: but it is obvious, that the mere absence of any impression, by the removal of the object which produced it, must as necessarily cause a change in the organ, nerves, and brain, as the presence of a new impression from a new object. To these changes, or that which *immediately* produces them, we give the name of *impressions*; because we know not how, in a general manner, to express more properly any change produced by an external cause, without specifying the nature of that cause. Whether it be pressure, or attraction, or repulsion, or vibration, or something unknown, for which we have no name, still it may be called an impression.

Sir Isaac Newton was perhaps the first who supposed that the rays of light falling upon the bottom of the eye excite vibrations in the *tunica retina*; and that those vibrations being propagated along the solid fibres of the optic nerves into the brain, cause the actual sensation of seeing. This hypothesis was adopted by Dr Hartley, applied to the other senses, and shown to be at least as probable as any which has yet been invented to account for the perception of external objects by means of the organs of sense. Be this as it may, experience informs us, that whatever be the nature of those impressions and changes which are made by external objects upon the senses, nerves, and brain, we have without them no actual sensation, and of course perceive nothing *ab extra*. Hence it has been supposed, that the mind is wholly passive in sensation, and that sensation is *necessarily* produced by those impressions. But this we believe to be a mistake. Every man who has been attentive to his own thoughts and actions, must know instances of impressions having been certainly made upon his organs of sense without producing any sensation, or suggesting to his mind the perception of the particular objects by which the impressions were caused. He whose mind is intensely employed in any particular pursuit, may have his eyes open upon an object which he does not see; or he may not hear the sound of a clock striking within two yards of him: Nay, we will venture to affirm, that there is hardly one reader of this article to whom such absences of sensation have not often occurred. Now, as there is no reason to suppose, that in the one case the undulations of the air, caused by the striking of the clock, did not reach his ears, or that in the other the rays of light, reflected from the object, did not fall upon his eyes, which were open to receive them; the only reason which can be assigned for his not having, in these instances, had audible and visible sensations, is, that his mind was so engaged in something else as not to pay to the vibrations in his brain that attention, if we may so say, without which impressions *ab extra* can produce no sensation. There are, indeed, some impressions on the organs of sense so violent and so sudden, as to force themselves upon the mind however employed. Such are those made on the ear by thunder, and on the eye by strong light. In these cases, sensation is involuntary and unavoidable; whence we conclude, not that in such instances the mind is passive or destitute of energy, but that by the violent agitation given to the brain, it is roused from its reverie, and compelled to give attention. It appears, therefore, that in sensation the mind exerts some kind of energy; for in nothing but in the sentient being itself can we

²⁰
In sensation
the mind
is partly
active.

seek for the cause why, when all external circumstances are the same, organical impressions sometimes produce sensations and sometimes not; and that cause can only be the energy of the mind: what kind of energy, we pretend not to say.

SECT. II. Of Perception by the Senses.

How the correspondence is carried on between the thinking principle within us and the material world without us, has always, as Dr Reid observes, been found a very difficult problem to those philosophers who consider themselves as obliged to account for every phenomenon in nature. It is, indeed, a problem of which we expect not to see a complete solution. A few steps beyond the vulgar we may certainly go; but the nature of that connection by which the mind and body are united, will probably remain for ever unknown. One question, however, which has employed much of the attention of philosophers, both ancient and modern, appears to be not wholly unanswerable. It is, Whether by means of our senses we perceive external objects mediately or immediately; or in other words, Whether sensation and perception be one and the same thing, or two things succeeding each other? On this subject, till of late, there appears to have been in the main a great uniformity in the sentiments of philosophers, notwithstanding their variations respecting particular points. Of some of the most eminent of them, we shall give the opinions as we find them collected by one * who is well acquainted with their writings, who is thoroughly qualified to estimate their respective merits, and who cannot be suspected of partiality to that theory, which we feel ourselves compelled to adopt.

"Plato illustrates our manner of perceiving external objects thus: He supposes a dark subterraneous cave, in which men lie bound in such a manner as that they can direct their eyes only to one part of the cave. Far behind there is a light, of which some rays come over a wall to that part of the cave which is before the eyes of our prisoners. A number of men variously employed pass between them and the light, whose shadows are seen by the prisoners, but not their persons themselves. In this manner did that philosopher conceive, that by our senses we perceive not things themselves, but only the shadows of things; and he seems to have borrowed his notions on this subject from the disciples of Pythagoras.

"If we make due allowance for Plato's allegorical genius, his sentiments with respect to sensation and perception correspond very well with those of the Peripatetics. Aristotle, the founder of that school, seems to have thought, that the soul consists of two or three parts, or rather that we have three souls—the vegetable, the animal, and the rational. The animal soul he held to be a certain *form* of the body, which is inseparable from it, and perishes at death. To this soul the senses belong: and he defines a sense to be that which is capable of receiving the sensible forms, or species of objects, without any of the matter of them; as wax receives the form of the seal without any of its matter. Of this doctrine it seems to be a necessary consequence, that bodies are constantly sending forth, in all directions, as many different kinds of forms without matter as they have different sensible qualities. This was according-

Of Percep-
tion.

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Difficult to
account for
the percep-
tion of
objects.

* Dr Reid in
his *Essays on*
the *Intellec-
tual Powers*
of *Man*.

²²
The hypo-
thesis of
Plato;

²³
Of Ari-
stotle;

Of Percep-
tion.Of Percep-
tion.

ly maintained by the followers of Aristotle, though not, as far as we know, taught by himself. They disputed concerning the nature of these forms or species, whether they were real beings or nonentities: but of matter and form we shall have occasion to speak afterwards.

24.
Of Des
Cartes ;

"After Aristotle had kept possession of the schools for more than a thousand years, his authority, which had often supplied the place of argument, was called in question by Lord Bacon and others. Des Cartes, however, was the first philosopher who, convinced of the defects of the prevailing system, attempted to form another entirely new: but on the nature of perception by means of the senses he differs little or nothing from those who had preceded him in that department of science. He denies, indeed, and refutes by solid reasoning, the doctrine which maintains that *images, species, or forms* of external objects, come from the objects themselves, and enter into the mind by the avenues of the senses. But he takes it for granted, as all the old philosophers had done, that what we immediately perceive must be either in the mind itself, or in the brain, to which the mind is immediately present. The impressions made upon our organs, nerves, and brain, can be nothing, according to his philosophy, but various modifications of extension, figure, and motion. There can be nothing in the brain like *sound or colour, taste or smell, heat or cold*. These are sensations in the mind, which, by the laws of the union of the soul and body, are raised on occasion of certain traces in the brain; and although he sometimes gives the name of ideas to these traces, he does not think it necessary that they should be perfectly like the things which they represent, any more than that words and signs should resemble the things which they signify.

"According to this system it would appear, that we perceive not external objects *directly* by means of our senses; but that these objects, operating either mediately or immediately upon the organs of sense, and they again upon our nerves and brain, excite in the mind certain sensations; whence we *infer* the existence of external objects from our sensations of which they are the cause. Perception of external objects, therefore, according to Des Cartes, is not one simple original act of the mind, but may be resolved into a process of reasoning from effects to causes."

25
Of Male-
branche ;

The doctrines of Malebranche, Locke, and Hartley, respecting perception, differ not essentially from that of Des Cartes. Malebranche, indeed, supposes, that external objects are not themselves the causes of perception; but that the Deity, being always present to our minds more intimately than any other being, does, upon occasion of the impressions made upon our organs of sense, discover to us, as far as he thinks proper, and according to fixed laws, his own ideas of the object: and thus, according to him, we see all things in God, or in the divine ideas. He agrees, however, with Des Cartes and the ancient philosophers, in considering it as a truth which it is impossible to question, that we perceive not the objects without us, the sun, moon, and stars, &c. because it is not likely that the soul falls out of the body, and takes a walk, as it were, through the heavens to contemplate these objects. She sees them not therefore by themselves;

and the immediate object of the mind, when it sees the sun, is not the sun itself, but something which is intimately united to the mind, and is that which he calls an *idea*.

Locke, speaking of the reality of our knowledge, Of Locke.

says: "It is evident the mind knows not things immediately, but only by the intervention of the *ideas* it has of them. Our knowledge, therefore, according to him, is real only so far as there is a conformity between our ideas and the things which they represent." The manner of our perceiving external objects he illustrates by the following similitude: "Methinks the understanding is not much unlike a closet wholly shut from light, with only some little opening left, to let in external visible resemblances or ideas of things without. Would the pictures coming into such a dark room but stay there, and lie so orderly as to be found upon occasion, it would very much resemble the understanding of a man in reference to all objects of sight, and the ideas of them *." He has elsewhere † defined an *idea* thus: "Whatsoever the mind perceives in itself, or is the immediate object of perception, thought, or understanding, that I call an *idea*; and the power to produce any idea in our mind, I call the *quality* of the subject wherein the power is." He likewise thinks it "easy to draw this observation, that the ideas of what he calls primary qualities of bodies, viz. *extension, solidity, figure, and mobility, &c.* are resemblances of these qualities as they really exist in the body themselves."

This unguarded expression, which affirms that ideas in the mind are the resemblances of external things, has brought upon Mr Locke much undeserved ridicule. That on this and other occasions he uses the word *idea* with too great latitude, and that he often confounds ideas with sensations, and even with the causes of sensation, must be admitted by his warmest admirers: but we believe, that by an attentive reader, who peruses his whole work, and compares such passages as are obscure with those which are clearer, his meaning may always be discovered, and with respect to sensation and perception will generally be found just. That by calling the ideas of primary qualities resemblances of the qualities themselves, he meant nothing more than that bodies in all possible states impress the senses, nerves, and brain, in such a manner as to produce in the mind certain sensations: between which and those impressions there is an inseparable, though unknown, connection, is evident from the account which he gives of the manner of perception. "Our senses (says he), conversant about particular sensible objects, do convey into the mind several distinct perceptions of things, according to those various ways in which these objects affect them: and thus we come by those ideas we have of *yellow, white, heat, cold, soft, hard, bitter, sweet*, and all those which we call sensible qualities; which when I say the senses convey into the mind, I mean, they from external objects convey into the mind what produces those perceptions." And as bodies can act only by impulse, he adds, that "those perceptions can be produced only by an impression made upon the senses, and some motion thence continued by our nerves to the brain or seat of perception."

Dr Hartley was the pupil of Locke and Newton; and has, in a more satisfactory manner than all who had

* Essay on
the Under-
standing,
book ii.
chap. 11.
† Book ii.
chap. 8.

27
Of Hartley.

Of Percep-
tion.

had preceded or have since followed him, explained the material part of the process of perception. His principles we shall have occasion, during the course of the article, to develop pretty fully. For our present purpose it is sufficient to say, that all his observations and arguments evidently suppose, that nothing distant from the mind can be perceived in the immediate act of sensation; but that the apparently immediate perception of external objects is an instance of early and deep-rooted association.

28
Of Hume.* Inquiry
concerning
Human Un-
derstanding,
sect. ii.

In this sentiment Mr Hume agrees with his predecessors; but he obscures his philosophy, and misleads his reader, by confounding sensations with the impressions from which they proceed. "Every one (says he *) will allow, that there is a considerable difference between the perceptions of the mind, when a man feels the pain of excessive heat, or the pleasure of moderate warmth, and when he afterwards recalls to his memory this sensation or anticipates it by his imagination." The less forcible and lively of these perceptions he with great propriety calls *ideas*; but it is either through wilful perverseness, or confusion of intellect, that he chooses to call the others *impressions*. Sensation and perception are caused by *impressions*; but they are no more impressions themselves, than the pain occasioned by the stroke of a bludgeon is the stroke itself, or the bludgeon with which it was struck. But more of this afterwards.

29
Agreement
of philoso-
phers, and
the reason
of it.

† See Mo-
sheim's edi-
tion of Cud-
worth's In-
tellectual Sy-
stem, where
the opinions
of the phi-
losophers of
antiquity
are more
faithfully
collected
than in any
other work
with which
we are ac-
quainted.

Thus far, then, that we perceive not external objects *directly*, but infer their existence from certain sensations excited in our minds by the operation of these objects upon our *senses, nerves, and brain*, seems to have been the opinion of every philosopher from Pythagoras † to Mr Hume. For an opinion so universal, and at the same time so contrary to the persuasion of the multitude, some cogent reason must have been assigned. That reason has been given by many philosophers, but by none with greater perspicuity than the late Dr Porterfield in his essay concerning the motion of the eyes. "How body acts upon mind, or mind upon body (says he), I know not; but this I am very certain of, that nothing can act, or be acted upon, where it is not: and therefore, our mind can never perceive any thing but its own proper modifications, and the various states of the sensorium to which it is present. So that it is not the external sun and moon, which are in the heavens, that our mind perceives, but only their image or representation impres-

Nº 213.

fed on the sensorium. How the soul of a seeing man sees those images, or how it receives those ideas from such agitations in the sensorium, I know not; but I am sure it can never perceive the external bodies themselves to which it is not present."

This reasoning appears to have force; and, perhaps, the unanimous agreement of thinking men in all ages has still greater force: yet the doctrine which has prevailed so long, and which to Locke appeared so evident as to need no proof, has been lately called in question by some eminent philosophers of our own country; who, though they allow that we cannot perceive external objects but by means of the senses, yet affirm that they are the objects themselves which we perceive directly; and that in perception there is no association which can be resolved into a process of reasoning from sensations the effects, to external objects the causes. Dr Reid, who was perhaps the first, and is unquestionably the ablest of this class of philosophers, has expressed himself on the subject as follows.

"If we attend to the ACT of our mind which we call the perception of an external object of sense, we shall find in it these three things: *first*, Some conception or notion of the object perceived. *Secondly*, A strong and irresistible conviction and belief of its present existence. And, *thirdly*, That this conviction and belief are immediate, and not the effect of reasoning ‡." To the first and second of these propositions, we are persuaded that Des Cartes and Locke would readily have assented; nor do we imagine that they would have denied the third, had the author allowed that this strong and irresistible conviction is the consequence of an early and deep-rooted association resolvable into a process of reasoning. This, however, the learned professor does not allow; for he repeatedly affirms, that it is instinctive and original, and that "the constitution of our power of perception determines us to hold the existence of what we distinctly perceive as a first principle, from which other truths may be deduced, but it is deduced from none." With this view of the matter, he could with no propriety attempt to support his own opinion by argument; but to the reasonings of Dr Porterfield and others in defence of the Cartesian theory, he replies in the following words: "That nothing can act immediately where it is not, I think must be admitted (D); for I agree with Sir Isaac Newton, that power without substance is inconceivable. It is a conse-

(D) One of the most celebrated of Dr Reid's followers thinks otherwise. "That no distant subject can act upon the mind, is a proposition (says Lord Kames) which undoubtedly requires evidence; for it is not instinctively certain: And, therefore, till the proposition be demonstrated, every man may without scruple rely upon the conviction of his senses, that he hears and sees things at a distance." But his Lordship ought to have known, that Locke and Berkeley, the two philosophers whom he was combating, have nowhere called in question the conviction of their senses. They do not, indeed, admit, that the external organs are themselves percipient, or that by means of them the mind can *immediately* perceive distant objects; but they have nowhere denied, that through the *medium* of them the mind comes to the knowledge of external existence. And the reasons which they assign for this twofold opinion are, that in perception they experience action or the effects of action, which is not their own; and that it is an intuitive truth, that nothing can act where it is not present. "But admitting (says his Lordship) that no being can act but where it is, is there any thing more simple or more common, than the acting upon subjects at a distance by intermediate means? This holds in fact with respect both to seeing and hearing." It certainly does, and with respect to the other senses likewise; but it is the very thing for which Locke and Berkeley would have contended, had any man in their days presumed to call it in question. It is the very foundation of their system; and if it be granted, nothing can be more evident than that external existence is not the *immediate* object of perception. See *Appendix to Elements of Criticism*.

Of Percep-
tion.

consequence of this, that nothing can be acted upon immediately where the agent is not present: let this, therefore, be granted. To make the reasoning conclusive, it is farther necessary, that when we perceive objects, either they act upon us, or we act upon them. This does not appear self-evident, nor have I ever met with any proof of it †."

† *Essays on the Intellectual Powers of Man*, Essay ii. chap. 14.

Of the profundity of Dr Reid's understanding, we have the most firm conviction; nor is there any metaphysician, ancient or modern, from whom we differ with greater reluctance: but we cannot help thinking this a very rash assertion, as his own works appear to us to afford complete proof, that, in perception, the mind both acts and is acted upon. Let us attend however to the reasons which, on this occasion, induce him to think that in perception there is no action either of the object on the mind or of the mind on the object.

"When we say, that one being acts upon another, we mean, that some power or force is exerted by the agent, which produces, or has a tendency to produce, a change in the thing acted upon. If this be the meaning of the phrase, as I conceive it is, there appears no reason for asserting, that in perception, either the object acts upon the mind or the mind upon the object. An object, in being perceived, does not act at all. I perceive the walls of the room where I sit; but they are perfectly inactive, and therefore act not upon the mind. To be perceived, is what logicians call an external denomination, which implies neither action nor quality in the object perceived."

32
We think unsuccessfully; and

This last sentence we pretend not to understand. Substance without qualities is to us inconceivable, and certainly is no object of perception; for Dr Reid himself has told us, and told us truly, that "the objects of perception are the various qualities of bodies." That an object in being perceived does not act at all, is directly contrary to what the ingenious author has taught us, both in his *Inquiry* and in his *Essays*, viz. that "it is a law of our nature that we perceive not external objects, unless certain impressions be made by the object upon the organ, and by means of the organ upon the nerves and brain;" for if the external object in being perceived make impressions, it is certainly not true that it acts not at all. It is indeed readily acknowledged, that when one perceives the walls of the room where he sits, these walls do not act immediately upon the organs of sight; but it does not, therefore, follow, that they are perfectly inactive: for it is known to all mankind, that from every point of the wall which is seen, rays of light are reflected to the eye; that those rays make upon the *retina tunica* an impression, which is conveyed by the optic nerve to the brain; and that this impression on the brain is one of the immediate causes of vision. In what particular manner it causes vision, we shall never be able to discover, till we know more of the laws which unite mind and body, and by which one of these is qualified to act upon the other; but because we know not the manner of this operation, to affirm that there is no operation at all, seems to be as absurd as it would be to affirm, because we perceive no necessary connection between a stroke and the sensation of sound, that the sound of a musical string is not cau-

fed by the stroke of a plectrum. That God might have given us powers of perception of a different kind from those which we possess, there can be no doubt; but with what we might have been, we have no concern. As we are, we know perfectly that the eye is an instrument of vision, because without it nothing can be seen: we know also, that the retina and optic nerves are equally necessary; because if they be disordered, vision is still wanting: we know likewise, that the brain is necessary to all perception; because, when it is disordered, thinking either entirely ceases or is proportionably disturbed. And, lastly, we are not more certain of our own existence, than that *actual perception* takes not place but when the object makes an impression upon some organ of sense: for when no rays of light fall upon the eye, we see nothing; when no sapid body is applied to the tongue and palate, we taste nothing; and if we could be removed from every thing solid, we would feel nothing. These are conclusions which cannot be controverted. They are admitted equally by the philosopher and by the plain unlettered man of common sense; nor are they rendered one whit less certain by our not being able to go a step farther, so as to discover in what manner the brain or the affections of it can be the immediate instrument of sensation and perception. For (as Dr Reid, in the spirit of true philosophy, observes †), "in the operations of mind, as well as in those of bodies, we must often be satisfied with knowing that certain things are connected and invariably follow one another, without being able to discover the chain that goes between them. It is to such connections that we give the name of *laws of nature*: and when we say that one thing produces another by a law of nature, this signifies no more, but that one thing which we call in popular language *the cause*, is constantly and invariably followed by another which we call *the effect*; and that we know not *how* they are connected."

† *Inquiry into the Human Mind*, 4th edit. p. 258.

In the preceding section we have observed, that in sensation the mind exerts some energy; and therefore, as on every hypothesis perception is a consequence of sensation, it follows, that in perception the mind cannot be wholly inactive. Dr Reid, in his *Essays on the Intellectual Powers of Man*, seems to affirm that it is. "I see no reason (says he) to believe, that in perception the mind acts upon the object. To perceive an object is one thing, to act upon it is another: Nor is the last at all included in the first. To say that I act upon the wall, by looking at it, is an abuse of language, and has no meaning." This is indeed true: it would be a great abuse of language to say, that by looking at the wall a man acts upon it; but we do not believe that any man ever said or supposed such a thing. The philosophers whose opinion he is combating, might argue in this manner. We are conscious that in perception the mind is active; nothing can act immediately where it is not; the mind cannot act immediately upon external existence: external existence, therefore, is not the immediate object of that energy which is exerted in perception. As Dr Reid affirms that external existence is the immediate object of perception, he must deny the first proposition in this argument; for if it be granted, as we have just seen that in his reply to Dr Porterfield he admits the

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second, the laws of reasoning will compel him to admit the third. To say, that in perception the mind acts not upon *external* objects, is a truth in which all mankind are agreed; and it is the very principle from which his antagonists infer, that the conviction of the present existence of external objects is not an original and instinctive consequence of sensation, but an early and deep-rooted association which may be resolved into a process of reasoning. His meaning, therefore, must be, that in perception the mind *acts not at all*: but this is directly contrary to his definition of perception, which he calls an act of the mind: it is likewise contrary to his theory of perception, as it is detailed in *the Inquiry into the Human Mind on the principles of Common Sense*. We are there taught, with equal elegance and perspicuity, "that an impression made by an external object upon the organ, nerves, and brain, is followed by a *sensation*, and that this sensation is followed by the perception of the object." We are likewise taught, that "although the Peripatetics had no good reason to suppose an active and passive intellect, they yet came nearer the truth, in holding the mind to be, in sensation, partly passive and partly active, than the moderns in affirming it to be purely passive. Sensation, imagination, memory, and judgment, have by the vulgar, in all ages, been considered as acts of the mind. The manner in which they are expressed in all languages shows this: for when the mind is much employed in them, we say, it is very active; whereas, if they were impressions only, we ought to say that the mind is very passive." All this is undeniable; but if sensation necessarily precede perception, and if in sensation the mind be active, what becomes of the assertion, that in perception it acts not at all? Indeed we may appeal to the common sense of mankind, whether any thing can be perceived without some mental energy of the percipient. For when the impressions made on the external senses are faint, in order to be conscious of them an evident exertion is requisite, not of the organ only, but also of the mind, as in perceiving very remote objects and sounds; but when the impressions are stronger, the perception is involuntary and unavoidable, as has been already explained in the preceding section.

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§ Hartley's
Observations
on Man.

It being thus certain that in perception the mind both acts and is acted upon, and it being universally acknowledged that nothing can act where it is not, we feel ourselves compelled to admit with the Cartesians, that in perception the conviction of the present existence of external objects is not original and instinctive, but the consequence of an early and unavoidable association of certain sensations with the causes which produce them. In this opinion we are still more confirmed by the well-known fact, that particular pressures upon the organ, nerves, and brain, excite not only sensations, but even perceptions of objects apparently external, when no such objects are within the reach of our senses. Thus §, if a man in the dark press either corner of his eye with his finger, he will see a circle of colours like those in the feather of a peacock's tail, though no such external object be before him, and though the room be so dark that nothing external could possibly be seen. Again, if a burning coal be nimbly moved round in a circle, with gyrations continually repeated, the whole circumference of the circle will at once appear on fire, though

it is certain that there can be really on fire but one portion of that circumference, equal in length to the diameter of the coal. These are facts known to all mankind; and they are perfectly irreconcilable with the supposition, that the perception of external objects by the sense of sight is original and instinctive; but they are at once accounted for, if it be true that rays of light falling from external objects upon the *retina tunic* agitate the optic nerves and brain, and that such agitations excite sensations in the mind which experience has taught us to refer to external objects, as, under God, their ultimate cause.

But though we have declared ourselves to be in this instance Cartesians, we do not admit all the absurdities which have sometimes been imputed to that system of perception. We do not believe that external objects are perceived by means of images of them in the mind or the brain; nor do we think that Des Cartes or Locke has any where affirmed that they are, otherwise than by an expression obviously figurative, denoting, not that the actual shapes of things are delineated in the brain or upon the mind, but only that impressions of some kind or other are conveyed to the brain by means of the organs of sense and their corresponding nerves; and that between those impressions and the sensations excited in the mind, there is a real, and in our present state a necessary, though unknown, connection.

Upon the whole, we think that there is good evidence for believing, that in perception the process of nature is as follows: *First*, If the object be not in contact with the organ of sense, there must be some medium which passes between them; as, in vision, the rays of light; in hearing, the vibrations of elastic air; and in smelling, the effluvia of the body smelled; otherwise we have neither sensation nor perception. *Secondly*, There must be some action or impression upon the organ of sense, either by the immediate application of the object, as in the two senses of touch and taste; or by the medium that goes between them, as in the other three senses. *Thirdly*, The nerves which go from the brain to the organ, must receive some impression by means of that which was made upon the organ; and by means of these nerves that impression must be carried to the brain. *Fourthly*, The impression made upon the organ, nerves, and brain, rouses the dormant energy of the mind; and this double action of the mind and the object produces a sensation. And, *lastly*, As we know by experience that the mind alone cannot by any exertion of its own produce one sensation, and are intuitively certain that nothing can begin to exist without a cause, we infer from the existence of any new sensation the existence of some other cause than the internal energy of the mind, from which that sensation proceeds; and this cause experience teaches us to be the external object. This process is carried on so rapidly, and the several parts of it, by being continually repeated, are so closely associated, that except by a reflex act of the mind we distinguish them not from one another, and therefore we denominate the whole *perception*.

It is with extreme diffidence that we advance a doctrine which Dr Reid has controverted; but he differs from us only in the last stage § of the process, where he supposes sensation and perception to be two simple and independent acts of the mind. Yet he sometimes expresses

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Shown to
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from Dr
Reid's.
§ See *In-
quiry into
the Human
Mind*, 4th
edit. p. 383.

Of Perception.

§ *Essays on the Intellectual Powers of Man, Essay ii. chap. 15. and 21.*

expresses himself, as if he thought as we do, that in perception the belief of the present existence of external objects is rather the result of experience than an instinctive persuasion. Thus, speaking of the perception which we have in smelling a rose, he says §, "Perception has always an external object, and the object of my perception in this case is that quality in the rose which I discern by the sense of smell. Observing that the agreeable sensation is raised when the rose is near, and ceases when it is removed, I am led by my nature [we think *by experience* would have been more proper] to conclude some quality to be in the rose, which is the cause of this sensation. This quality in the rose is the object perceived; and that act of my mind, by which I have the conviction and belief of this quality, is what in this case I call perception." Again (he says) that "three of our senses, viz. smell, taste, and hearing, originally give us only certain sensations, and a conviction that these sensations are occasioned by some external object. We give a name to that quality of the object by which it is fitted to produce such a sensation, and connect that quality with the object and with its other qualities. Thus we learn, that a certain sensation of smell is produced by a rose; and that quality in the rose by which it is fitted to produce this sensation we call the *smell of the rose*. Here it is evident that the sensation is original. The perception that the rose has that quality which we call its *smell*, is acquired."

To this doctrine no Cartesian could possibly object; for it is the very account which Des Cartes himself would have given of perception by the organ of smell, as it resolves such a perception into an early association between a certain sensation and that external quality from which we know by experience that the sensation proceeds. Indeed the excellent author repeatedly affirms, that every different perception is conjoined with a sensation which is proper to it; and that the one is the sign, and the other the thing signified. He likewise doubts *, whether children, from the time that they begin to use their senses, make a distinction between things which are only conceived or imagined, and things which really exist. But if the conviction of the present existence of external objects were in perception *instinctive*, we cannot see how there could be room for such a doubt: for the mere senses of children are as perfect as those of full grown men; and they know well the difference between actually sucking their nurses and only thinking of that operation, though they be not capable of expressing that difference in language.

* *Essays on the Intellectual Powers of Man.*

36 Both theories afford intuitive evidence that something exists besides the perception and the sensation.

But if in perception our conviction of the present existence of external objects be not instinctive, what, it may be asked, is the evidence that such objects really exist? This question we shall partly answer in the following section, and more completely when we come to examine Berkeley's theory of the non-existence of matter: but from what has been said already, it is sufficiently evident, that every sensation compels

us to believe in the present existence of something different from ourselves, as well as from our sensations.

Objects of the respective Senses.

SECT. III. Of the Objects of each Sense respectively.

HITHERTO we have considered sensation and perception in general, and shown that it is not by instinct that we perceive the existence of external objects. This will appear more clearly, if we can ascertain the precise nature of that information which each sense affords us: and in order to this, we shall begin with the sense of *touch*, not only because it is that which is certainly first exercised, but also because there is a meaning in which all the others may be resolved into it.

By means of touch we perceive many things; of which the chief are, heat and cold, hardness and softness, roughness and smoothness, extension, figure, solidity, and motion. Of these perceptions, some are immediate; and others, as we are persuaded, early associations, which may be resolved into a process of reasoning. The perceptions of heat and cold are immediate. When a person for the first time in his life approaches the fire, he feels heat; and when he is first exposed to the frost, he feels cold. What are heat and cold, and where do they reside? They are obviously the reverse of each other; but are they external objects, or mere sensations in the mind? They are undoubtedly sensations which have no existence but when they are felt. To every man not altogether a stranger to these speculations, this proposition is self-evident; but to the bulk of the people it appears an extravagant paradox. To make it plain, however, to the meanest capacity, it is sufficient to observe, that at a certain distance the fire has no perceptible influence upon any person; if that distance be lessened, we feel an agreeable warmth; approach a little nearer, and the warmth becomes disagreeable; and still nearer, it will rise to pain. No man supposes the pain inflicted by a sword to exist in the sword, or any where else but in a sentient being: It is equally absurd to suppose pain to exist in fire, or any where else but in a sentient being. But that which at one distance is pain, at another is only agreeable warmth; and since warmth and pain are only different degrees of the same feeling, it is equally absurd to suppose the one as the other in the fire. What then is the object of sense when we feel heat? There is obviously no object beyond the present sensation.

But has the sensation of heat no cause independent of us? Undoubtedly it has, and experience teaches us that the cause is in the fire. We know that we cannot produce the sensation of heat in ourselves by any mental energy of our own; and we are intuitively certain, that nothing can begin to exist without some cause. A man on the top of a mountain covered with snow, may imagine or remember what he felt when in the neighbourhood of fire, and thus have in his mind what is called an *idea* of heat; but that idea will not warm him (E) like the actual sensation, which no exertion of his own can in such circumstances produce.

37 Touch, the sense by which we perceive heat and cold, &c.

38 The nature of heat and cold, which are perceived immediately.

39 Their external causes.

3 Q 2

When

(E) — Who can hold a fire in his hand,
By thinking on the frosty Caucasus?
Or cloy the hungry edge of appetite,
By bare imagination of a feast?

Or wallow naked in December's snow,
By thinking on fantastic summer's heat?
Oh no! the apprehension of the good
Gives but the greater feeling to the worse.

K. RICHARD II.

Objects of
the respec-
tive Senses.

When he leaves the mountain, however, and approaches the fire, he feels the sensation actually produced, and produced as often as he makes the experiment. He is, therefore, under the necessity of inferring, that in the fire there is some power or quality which, acting either mediately or immediately upon his sense of touch, excites the feeling which is called *heat*. What that power is, we shall perhaps never be able to discover; but it is self-evident, that it is neither heat nor the resemblance of heat, though in vulgar language it is known by that name.

The same reasoning holds good with respect to cold. There is at certain times, and in certain countries, some power in the air which congeals water and causes cold; but that power is as different from the sensation of cold, as the power of fire is different from the sensation of heat, or the point of a sword from a flesh wound.

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The per-
ceptions of
extension
and figure,
&c. not im-
mediate.

By the sense of touch we perceive extension, figure, and solidity, &c. but we do not perceive them *immediately* as we perceive heat and cold; for extension, figure, and solidity, are not sensations. Those perceptions then must be acquired; and more clearly to ascertain the manner in which we acquire them, let us suppose a man from his birth destitute of the sense of sight and the power of local motion, but possessed of intellect and every other faculty which we enjoy.—Such a person, it is obvious, would be capable of every sensation and perception which is *original* to us, except the perception of colours; but we doubt whether it would be possible to give him perceptions of extension, figure, and solidity. Let us try: and as he cannot move a single limb or member of himself, let us suppose a solid substance of small dimensions to be gently pressed against any part of his body; what would such pressure communicate to him? We think it could communicate nothing but a new sensation, to which, as it is neither pleasing nor painful, no name has hitherto been given, except the general one of *feeling*. This sensation he would not know whether to refer to an external or internal cause; or rather he could have no notion whatever of an external cause, though he would at the same time be conscious that the new sensation was not excited by any energy of his own will. Were the pressure to be gradually increased till it rose to pain, our blind man would still be conscious of nothing but a sensation, which could not lead him to the notion of extension, figure, or solidity, because mere sensations cannot be conceived as either solid or extended. Let us next suppose the pressure to be applied successively to different parts of his body; he would now indeed be conscious of successive sensations, but he could not assign to them either extension or *place*: for it has been already shown that the external parts of the body are not themselves sentient; and it shall be shown afterwards, that to a man who has never perceived motion, place is absolutely inconceivable. Lastly, let us suppose the dimensions of the pressing substance to be greatly enlarged: what would then follow? nothing, we apprehend, but an increase of pain: for though his whole body were pressed *ab extra*, the pressure could affect the individual being which is sentient, not more extensively, but only more violently. It appears, therefore, that a man blind from his birth, and destitute of the power of local mo-

tion, could never be made to perceive extension, figure, or solidity.

Let us now suppose this man to receive by a miracle the use of his limbs, and to be suddenly prompted, by some instinctive impulse, to arise and walk. So long as he met with no obstacle in his way, he would not, we apprehend, acquire by this exercise any correct notions of extension or figure; but were a stone or log of wood of considerable dimensions to be laid across his usual walk, the case would soon be altered. He would feel himself interrupted in his course, and he would at the same instant recognize his wonted sensations of touch. After being twice or thrice thus interrupted, he would learn from experience that the interruption or resistance proceeded from the same cause which in this instance communicated to him the sensation of feeling; and were he to run his hand along the surface of the log or stone, he would perceive the resistance and the sensation continued. As every effect must have an adequate cause, this continued resistance would compel him to believe the continuity of something external in every direction in which he felt his hand resisted; but such continuity of being is all that is meant by the word extension. At the very same time, and by the very same means, he would gradually acquire the perception of figure; for by running his hand in every direction over the surface of the obstacle which opposed him, he would soon perceive it on all sides limited; but the limits of extension is a phrase of precisely the same import with figure. It appears, therefore, that without the power of local motion, men could never by the sense of touch acquire the notions of extension and figure; and the same will be found to be the case with respect to hardness and softness.

When we press our hand gently against a stock or a stone, we feel a sensation which is neither painful nor pleasing. When we press it more violently, the sensation becomes painful, and we experience in the object a resistance which we have not power to overcome. When we press butter or pomatum very gently, we have a sensation in all respects similar to that which we felt when we gently touched the stock or the stone. But when we press the butter with violence, we feel no pain, and experience little resistance; for the parts of which it is composed give way before the hand, though the parts of the stock or the stone remained fixed and immoveable. That the parts of one body should thus resist a pressure to which the parts of another so readily yield, must proceed from some difference in the texture of the two bodies: for by the sense of touch we perceive the effects to be different; and are therefore certain that they must proceed either from different causes, or from the same cause operating with different degrees of force. That particular texture which makes the parts of a stone resist the pressure of touch, we call hardness; and the texture which makes the parts of butter or pomatum give way to touch, we call softness. But what hardness and softness are in themselves, touch cannot inform us; for they are neither sensations, nor similar to sensations. We acquire, however, by experience, so complete notions of hardness and softness, that every one who understands the English language perfectly knows the meaning of these words as soon as he hears them; and when he is told that

Objects of
the respec-
tive Senses.

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How they
are ac-
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Hardness
and softness,
how per-
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Objects of
the respec-
tive Senses.

Objects of
the respec-
tive Senses.

43
Roughness
and smooth-
ness.

45
Nothing
but mere
sensations
the objects
of smell,

44
Solidity,
what; and
how per-
ceived.

46
Taste, and

47
Hearing.

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It is by ex-
perience

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that one body is hard and another soft, he knows with absolute certainty that the meaning of the assertion is, that the parts of the body which is said to be hard are held together by some unknown cause operating forcibly, and that the parts of the other are held together by the same or a similar cause operating with less force.

We acquire the notions of roughness and smoothness in the very same way and by the very same means that we acquire ideas of extension and figure. To describe the process at large would certainly be superfluous; for if what we have said concerning our perceptions of extension and figure be just and intelligible, every one will, without farther assistance, discover for himself how he perceives roughness and smoothness. *Motion* shall be considered among the adjuncts of body; but in order to understand what body itself is, it will be necessary, before we dismiss the sense of touch, to inquire how we come by the notion of solidity.

Solidity is one of those notions, or, in the language of Locke, one of those ideas, which are commonly said to be acquired by the sense of touch. That touch gives the first hint towards our notion of solidity, is certainly true; but that hint must be afterwards improved by the intellect, or we never could have an adequate knowledge of what is meant when any thing is said to be absolutely solid. We know by experience, that we can at pleasure open and shut our empty hand without meeting with any resistance. We know likewise, that when we grasp an ivory ball of three or four inches diameter, no force which we can exert will bring together the several parts of the hand, which were easily brought together when we grasped nothing. In this way do we acquire our first notion of solidity; for that word denotes nothing more in this instance than the power or property of the ball, by which our fingers are excluded from the place which it occupies. Solidity differs from hardness in this respect, that hardness results from the strong cohesion of the parts of a hard body, which renders it difficult to change the places of those parts, as they respect one another; whereas solidity respects the whole mass, and is as essential a quality of water as of adamant. A drop of water, indeed, placed between two plane surfaces of marble, will not like adamant preclude their contact; because the parts of a drop of water, cohering but loosely to one another, give way to the pressure, and escape in every lateral direction. But if a drop of water be confined on all sides, as in a globe of gold, we know from experiment that no force will bring the sides of the globe together without forcing the water through the pores of the metal; and hence we infer solidity to be essential to every corporeal substance.

Thus then it appears, that of the objects perceived by touch not one is *immediately* perceived except heat, cold, and other sensations. The sensations, as they are not excited by any internal energy of our own, lead us indeed to something external as their cause; and by comparing the different sensations with each other, and observing what effects their external causes have upon our own motions, we are naturally led to conceive these causes as extended, figured, solid, hard or soft, rough or smooth, &c.; but it is obvious that this conception is the result of experience, and a process of mental reasoning.

On the senses of taste, smell, and hearing, it is needless to say much. The immediate objects of these are confessedly sensations which have no existence but when they are perceived; though experience teaches us to refer them all to external objects as their respective causes. With respect to smell, this has been made sufficiently evident in the preceding section, and it is not less evident with respect to taste and hearing.

Certain bodies applied to the tongue and palate, and moistened with the saliva, excite certain sensations which we call tastes. These sensations, however, are not in the bodies; nor can they have any existence but in a sentient being. They are produced in consequence of impulses on the nerves of the tongue and palate, exciting certain agitations in the brain; but the sensation itself is neither impulse nor agitation. Some substances excite tastes which are agreeable, and others such as are disagreeable; and there are not a few which excite no taste at all. Bodies, which applied to the tongue and palate of one man produce tastes that are agreeable, applied to the same organs of another man give him tastes which are disagreeable; and we have all experienced, that the same substance, which, when the organs are sound, excites a sweet or pleasant taste, has, when the organs were disordered, excited a taste which was bitter or unpleasant. These facts, which cannot be controverted, afford the fullest evidence, if evidence were wanted, that taste, as we feel it, is no quality of bodies, nor has any existence out of the mind.

The organ of hearing is the ear, and its object is sound. It is well known, that sound is produced by certain vibrations of the air striking the tympanum of the ear, and that those vibrations are caused by the sonorous body. Sound, however, is not vibration, nor the idea of sound the idea of vibration. Sound considered by itself is a mere sensation, which can have no existence but in a sentient being. We know by experience, that it is caused by something external; but we know likewise that the effect has no resemblance to the cause. Previous to experience we could not refer sound to any external cause; far less could we discern whether it proceeded from an object above us or below us, on our right hand or on our left. It appears to us self-evident, that if a man born deaf were suddenly made to hear, he would consider his first sensation of sound as originating wholly within himself. Between that sensation and the sensations of touch, taste, smell, and sight, there is no resemblance; nor are there any relations among them, which, previous to experience, could induce him to trace them all to external objects as their several causes. Our deaf man might have learned to refer all his other sensations to their true causes, in some such way as we have described under the sense of touch; but sound would be something so new to him, and so totally different from touch, taste, and smell, that he could attribute it to nothing external.

Experience, however, would soon teach him, that the ear is its organ, and the sonorous body its cause; and he would in time learn to distinguish one sound, that of a trumpet for instance, from another, suppose the sound of a bell; and to attribute each to its proper cause, even when neither the trumpet nor the bell was perceived by his other senses. With respect to

Objects of
the respec-
tive Senses.

is done so instantaneously, that some philosophers have imagined it to be the effect of an instinctive principle in our nature, totally different from experience, and independent of reason. But the fact is not so. Long before we are capable of making sensation and perception objects of reflection, we have heard the sound produced by the ringing of a bell, and seen the object which produced the sound so often, that, when we hear a similar sound again, we instantly refer it to a *bell*, though we see not the bell from which it proceeds: but this is the effect of habit, and not of instinct. Had we never perceived a bell while ringing by either of our senses of sight or touch, we could not by the sense of hearing acquire any notion of the figure or texture of the body from which the cause of the sound proceeds, tho' we had heard that sound every day of our lives. It is, indeed, by experience only that we learn to distinguish by the ear whether a sonorous body be before or behind us, on our right hand or on our left; for we find it always difficult to say from what precise quarter a strange sound proceeds; and this difficulty would be heightened to impossibility, had not all sounds something in common. Dr Sparman relates, that when he first heard the roaring of a lion, he did not know on what side of him to apprehend danger, as the sound seemed to proceed from the ground, and to inclose a circle of which he and his companions stood in the centre. The same thing has happened to every man, when the sound was such as he had never heard before; even though it was neither so loud nor so terrific as the roaring of a lion in a desert wilderness: but with respect to sounds which we are daily hearing on each side of us, we soon learn to distinguish with tolerable accuracy whether they be before or behind us, above or below, on our right hand or on our left. All this, however, is the effect, not of instinct, but of experience improved into habit.

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Sight ori-
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Sight is justly considered as the noblest and most comprehensive of all our senses. The reason is obvious: for when a full-grown man opens his eyes, he perceives houses, trees, rivers, the earth, sun, and moon, &c. and to each of these objects belong figure, extension, colour, &c. which are all perceived instantly by means of this sense. Yet it is certain, that the sense of sight does not originally communicate to us so many perceptions; and there is abundant evidence, that an infant cannot at first, or for some weeks after its birth, distinguish by vision one object from another. *Colour* is the proper object of sight, and for some time its only object; but colour as perceived by us is a mere sensation, which can have no existence but in a sentient being. If this proposition stood in need of proof, we might observe that there are men, and even whole families, who possess the sense of sight in a degree of perfection sufficient for all the purposes of life, and yet cannot distinguish certain colours from each other; blue, for instance, from green, or perhaps from red: and there is no man who can distinguish between some particular shades of blue and green by the feeble light of a candle. Were colours the real qualities of body, this mistake of one for another could never be experienced. No man who possesses the sense of touch ever confounded hardness with softness, a sphere with a cube, or an ell with an inch. The reason is, that

hardness and softness, figure and extension, are the qualities of things external; whereas colour being a mere sensation, is nothing but an affection or modification of the sentient being. But it is obvious, that sentient beings, according as they differ from one another, may be differently affected by the same external cause; so that one man may perceive that to be green which all other men perceive to be blue. The immediate external cause of the sensation of colour, is the rays of light reflected from the body, which in common language is said to be coloured. These rays falling upon the pupil of the eye, are refracted differently, according as their incidence is more or less oblique into points on the retina, where they form a picture of the external object; and from the picture, by means of the optic nerve, is communicated to the brain some impulse or agitation, which produces vision or the perception of colour. As rays of light are corporeal substances, it is obvious that they can act upon body only by impulse; but between impulse and the various sensations of *red, green, blue, &c.* there is no resemblance. For the laws of reflection and refraction, and for the structure of the eye, see OPTICS and ANATOMY. That which we have to inquire into at present is, how we learn, by means of the sense of sight, to perceive the figure, magnitude, motion, and distance of external objects, or indeed to distinguish one object from another.

A ray of light proceeding, as all rays do, in a straight line, must, however great its length, affect the eye, retina, and optic nerve, as if it were a single point. From this obvious and undeniable fact, Bishop Berkeley predicted*, that a man born blind, who should be suddenly made to see, would at first perceive nothing without him, would distinguish neither the distance, size, figure, nor situation, of external objects; that he would only see in his eyes themselves, or, to speak more properly, would only experience new modifications in his mind, until joining *touch* to *sight*, he formed thus a communication with the external world, and learned, by the simultaneous exercise of the two senses, that natural language in which the *visible* is the sign of the *tangible*. This truth, which was discovered by the Bishop merely by contemplating in his own mind the nature of sensation, and the known laws of optics, after having been laughed at for more than 20 years as one of the many dreams of a visionary genius, was completely confirmed by the case of the famous patient whom Cheselden cured of a cataract; and that too, though the cataract does not produce total blindness: which makes it evident, that the first visual perceptions of the patient after his recovery could not be wholly new and unmixed. It may indeed be confirmed at any time by a simple experiment made upon an infant. For several weeks after birth, a child shuts not its eyes upon the sudden approach of an object to them, nor shows the least symptom of distinguishing one distance from another; and it is easy by a little attention to observe, how it gradually learns to distinguish objects at greater and greater distances. Indeed colour, or the immediate object of sight, being a mere sensation or affection of the mind, can have no natural relation whatever to any thing external.

It is plain, therefore, that distance is in its own nature

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tive Senses.

* *Essay to-
wards a
new Theory
of Vision.*

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the respec-
tive Senses.

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Perception
of distance
by sight,
how acqui-
red.

ture imperceptible to the eye, and yet it is often perceived by sight. How is this done? We think, in the following manner. Distance is one mode of extension, which, we have already seen, is perceived by means of touch. Of short distances, our first ideas are doubtless acquired by the stretching out and drawing back of our arms; and those ideas are soon so connected with certain sensations which we have in actual vision, that the latter instantly suggests the former. Thus, it is a fact known by experience, that when we look at a near object with both eyes, according as it approaches or recedes from us, we alter the disposition of our eyes, by lessening or widening the interval between the pupils. This disposition, or turn of the eyes, is attended with a sensation of which every man is conscious at the time of vision; and this sensation seems to us to be that which in this case suggests the idea of greater or less distance to the mind. Not that there is any natural or *necessary* connection between the sensation of which we are conscious, and greater or less distance; for the sensation is wholly internal, and the distance is external: But because the mind has, by constant *experience*, found the different sensations occasioned by different dispositions of the eyes to correspond to different degrees of distance in the object, there has grown an habitual or customary connection between those sensations and the notions of greater or less distance. So that the mind no sooner perceives the sensation arising from the different turn it gives the eyes in order to bring the *pupils* nearer or farther asunder, than it is instantly impressed with a certain notion of the distance which was wont to be connected with that sensation. Again, an object placed at a certain distance from the eye, to which the breadth of the pupil bears a sensible proportion, being made to approach nearer, is seen more confusedly; and the nearer it is brought, the confusion is always the greater. The reason of all this is known to every optician: but it being constantly experienced by those who never dipt into optics, there arises in the mind of every man an habitual connection between the several degrees of confusion and distance; the greater confusion still implying the less distance, and the less confusion the greater distance. It is of no avail to say, that between confused vision and distance, great or small, there is no necessary connection: for there is as little connection between a blush in the face and the mental feeling of shame; and yet no sooner does a man of observation perceive that particular colour in the face of another, than it suggests to him the notion of that feeling or passion with which he has constantly observed it accompanied.

In these ways, however, we perceive only small distances. Of distances more remote our judgment is formed from other data; and happily these data are not far to seek. It is a fact known to every man who is not totally ignorant of the science of optics, that a greater number of rays fall upon the eye when reflected from a body near at hand, than can fall from the same body at a distance; and as those rays operate by impulse, it is self-evident that the impression must be stronger, and of course the sensation or colour more vivid, when the body is near than when it is distant. Now having acquired the notion of the true distance of objects by motion and the sense of touch, and find-

ing by uniform experience, that as they are near or far off, the sensation or colour which they excite in the mind through the organ of vision is more or less vivid, those degrees of sensation come to be so closely associated with the respective distances of the object, that the one instantly suggests the other.

It is just so that we perceive figure by sight. Having experienced by the sense of touch that one surface is a square and another a circle, that one body is a cube and another a sphere; and finding our sense of sight differently affected by the square and the circle, by the cube and the sphere; these different affections come to be so closely connected in our minds with the figures of the respective bodies, that long before we are capable of reasoning on the subject the one is never present to us without suggesting the other. Nay, so complete in this case is the connection or association, that we cannot even in idea abstract the colour from the figure; though it is certain that colour is a mere sensation, and figure an external quality; that colour alone is immediately perceivable by the eye, and the notion of figure suggested by the colour. We are aware that it has been affirmed, and affirmed with great vehemence, that figures of two dimensions are immediately perceived by the eye, and perceived with greater accuracy than by the sense of touch. But they who insist upon this doctrine affirm likewise, contrary to experience and the clearest reasoning, that the immediate objects of sight are external, and that colour is a quality of bodies. In the arguments too by which they support their hypothesis, they seem to confound sight as an affection of the mind, with the picture on the bottom of the eye, as if the retina were the sentient being; whereas the retina and picture are no more than instruments of sensation. It is indeed a fact, that the picture has the same figure nearly with the plane of the object which is presented to the eye; as when the object is a sphere, the picture is a circle variously shaded in colour. It is likewise a fact, that the picture is enlarged in proportion as the object is brought near, and diminished as it is carried to a distance. But these facts are known only to persons skilled in optics; and therefore it is evident, that though calculations may be raised from them by mathematicians to determine the distance and figure of external objects, they cannot possibly be the data from which distance and figure are inferred by the vulgar, who know not that such pictures on the retina exist. Besides all this, it is universally known, that a painter, by laying on his colours properly, can make a plain square surface appear to the eye in certain positions as an oblong or as a cube, and a plain circular surface as a concave or a convex hemisphere. But not one of these things could possibly be done, were figure, or indeed any thing else than colour, the immediate object of vision.

As we see distance and figure, so we see magnitude; and we see both in the same way that we see shame or tude. anger in the looks of a man. The impression made upon the bottom of the eye by rays reflected from a large magnitude, must necessarily be different from the impression made by rays reflected from a magnitude that is less. This is self-evident: and since the impression *ab extra* is in some way or other the cause of that sensation, which is all of which we are originally conscious in vision, it is obvious that the sensation, like

Objects of
the respec-
tive Senses.

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How figure
is perceived
by sight.

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Magni-

Objects of
the respec-
tive Sens. s.

like every other effect, must correspond to the cause from which it proceeds. Being therefore conscious of different sensations; and having, at an earlier period than we distinctly remember, learned by experience to refer them to different magnitudes; no sooner is each sensation excited than it suggests the notion, or if you please the perception, of that magnitude with which it is connected. So completely is this association fixed in the mind, that when we look at a known object, its real magnitude appears to be as instantly observed as its colour, whilst we hardly attend at all to the particularity of the sensation by which the magnitude is suggested. It is indeed customary with writers on optics to distinguish between tangible and visible magnitude, as if any kind of magnitude were the immediate object of vision: but this is not so; for magnitude is something external, whereas the immediate object of vision is a mere sensation. What has introduced into science this mode of speaking is the following fact, that as we approach a distant object it appears to the eye larger and larger every step, and less and less as we recede from it; whereas the tangible magnitude of an object is always the same. The reason of this apparent change of magnitude to the eye, according to the distance at which any particular object is viewed, is, that from a near object rays of light fall in greater numbers and more diverging than from the same object viewed at a distance. This of course alters the nature of the visible sensation: each common sensation is in the mind closely linked with a particular notion of magnitude; and by the exercise of sight and touch we have learned from experience, that the particular sensation caused by diverging rays must be referred to a larger magnitude than that which is caused by parallel rays proceeding from the same distance.

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Visible sen-
sations a
kind of na-
tural lan-
guage.

Upon the whole, then, we think ourselves intitled to conclude, that the proper and original objects of vision constitute an universal language of the Author of Nature, by which we are instructed how to regulate our actions, in order to attain those things that are necessary to the preservation and well-being of our bodies, as also to avoid whatever may be hurtful or destructive to them. It is principally by the information of this language that we are guided in all the transactions and concerns of life: And the manner in which it signifies and marks to us the objects which are at a distance, is similar to that of languages and signs of human appointment, which do not suggest the things signified by any likeness or identity of nature, but only by an habitual connection, which experience has made us to observe, between them. This language of the eye, like the language of the tongue, suggests by one sensation what may be resolved into a variety of perceptions. A tree is composed of a trunk, branches, leaves; it has colour, figure, size; and all these things are at once suggested to the mind by the two words *spreading oak*. Just so it is with respect to vision: the sensation received by the eye suggests at once the *trunk, branches, leaves, colour, figure, and size* of the oak, and suggests them all as the qualities of one object.

CHAP. II. Of RETENTION and IDEAS.

FROM the experiment with the burning coal mentioned in n° 33, it is apparent, that sensations excited N° 213.

through the eye, together with their corresponding perceptions, remain in the mind for a short time after the external exciting cause is removed. The same thing appears from another experiment which was first made by Sir Isaac Newton, and which every man may repeat for his own satisfaction. It is universally known* that a proper mixture of the seven original colours, *red, yellow, green, blue, &c.* constitutes that uniform appearance which we call *white*. But when these colours are made to pass in a rapid consecution before the eye, they excite the very same perception as when they are properly mixed: which is a satisfactory proof that the impression made by each separate colour remains in the brain until a revolution of all the colours be completed; for nothing but the impression of all the colours at *once* can produce the sensation and perception of *white*. Indeed no person capable of paying the proper attention to these things, can keep his eye fixed upon a luminous object, and afterwards shut it, without experiencing that the sensation and perception remain for some time after the external object is shut out, and that they go off gradually till they leave behind them the mental appearance, which is properly called an *idea* of the object.

The same continuance of the sensation after the removal of its cause is equally observable in the sense of hearing: for every sound which we hear is reflected by the neighbouring bodies; and therefore consists in reality of a variety of sounds succeeding each other at different distances of time, according to the distances of the several reflecting bodies. Yet this causes no confusion or apparent complexity of sound, unless when the distance of the reflecting bodies is very considerable, as in spacious buildings.

With respect to the continuance of the sensation of touch, doubts have been started; but for these there is as little room as for doubting the continuance of the sensations of seeing and hearing. The continuance of heat after the heating body is removed, and of the smart of a wound after the instant of infliction, are proofs that every sensation of touch does not vanish with its cause. A man unused to the motion of a ship or a coach, after having been a day at sea or on the road, feels or imagines he feels the rolling of the ship or the jolting of the coach after he is in bed and actually at rest. Of these facts we know not what other account can be given, than that the agitation in the brain, which is the immediate cause of the sensation of touch, remains for some time after the external cause of the agitation is removed.

As to the senses of taste and smell, Dr Hartley seems to think that there is no clear and direct evidence for the continuance of their sensations after their proper objects are removed: but in this instance the ingenious author does not justice to his own theory. Let any man eat onions, garlic, or any other thing of a very pungent taste, and immediately wash his mouth with fresh water, so as that he may be sure no part of the sapid body remains on his tongue or palate. According to this doctrine, the taste of the onion or garlic should instantly vanish with its object; but the fact is otherwise. Whoever shall make the experiment, will find the sensation to remain a considerable time; not indeed in its original force, but weakened no more than what it must necessarily be by the introduction

Retention
and Ideas.
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Sensations
and percep-
tions re-
main for a
very short
time after
the remo-
val of their
objects.
* Hartley
on Man.

Retention
and Ideas.Retention
and Ideas.55
Hence we
have that
power or
faculty cal-
led memory.* See *An
Essay on
the Reduction
of the Facul-
ties of the
Mind*, by
M. Schwab.

of a new sensation excited by the water. It is more difficult to ascertain the permanency of smell: but analogy inclines us to believe, that in this particular it resembles the other senses, though we know not how to direct the reader to an experiment which will give him absolute conviction.

Whether the cause of these continued sensations, after the removal of their objects, be in the brain alone, in the mind alone considered as an immaterial being, or in both together, is of very little importance; because, taking the mind and its internal organs as one *metaphysical whole**, it matters not to our present inquiry, where this retentive power resides, as long as it can be proved to exist within us: for it seems evident, that what has the faculty of retaining a sensation when no longer acted upon by the object which excited it, must also have a power to preserve the vestiges of that sensation even after the sensation itself shall be entirely obliterated. This is in fact the case with the mind. When an object which we have once perceived is most remote from our thoughts, we are certain that there is within us a capacity, disposition, tendency, or power, by which a representation of that object may be at any time revived and presented to the intellect. Thus the same inherent power of the mind and its internal organs, which retains a sensation and perception in the absence of the object by which they were excited, can also reproduce that perception, or bring into the view of the intellect something exactly similar to it. The reproduction will not indeed be so lively as the original perception when accompanied with its corresponding sensation, because sensation and actual perception are effected by a double cause, the action of the external object upon the organ, nerves, and brain, and the corresponding energy of the mind or sentient principle: whereas, in the reproduction, the mind seems to act solely by its own power, and certainly without the assistance of external objects. This reproductive power is commonly called *memory*. By many of the ancient philosophers, and by M. Schwab, with one or two others among the moderns, it is called *imagination*. We do not choose either to revive antiquated modes of expression, or to introduce innovations of our own; but as we cannot disapprove of the ancient phraseology, after the definitions which the reader will by and by find of *imagination*, *memory*, and *recollection*, as given by Mr Harris, we have prefixed to this chapter the general title of *retention* which comprehends them all.

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The opinions
of philo-
sophers
respecting
memory.

When one recalls an object of sight by the power of memory, it appears to him precisely the same as in the original survey, only less distinct, and with a conviction (which is perhaps the result of experience) that the real object is not immediately before him. How is an object recalled by the power of memory? Does the man endeavour to form in his mind a picture or representative image of the object? Let us listen to the answers given by different philosophers to this question.

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(E) The original is as follows: Τι τοιουν ιστιν η φαντασια ωδε αι γνωρισαιμεν δει νοειν εν ημιν απο των ενεργειων των περι τα αισθητα, στον τυπον τινα αναλογησικον εν τω πρωτω αισθητηρια, εχκαταλειμμα τι της υπο του αισθητου γινομενης κινήσεως, ο και μηκετι του αισθητου παροντος, υπομενει τι και σωζεται, ον ωσπερ εικων τις αυτου, ο και της μνημης ημιν σωζομενον αιτιον γινεται το τοιουτον εχκαταλειμμα, και τον τοιουτον ωσπερ τυπον, φαντασιαν καλουσιν. Alex Aphrad. de Anima, p. 135. Edit. Ald.

The sentiments of the Peripatetics, as expressed by Alexander Aphrodisiensis, one of the earliest commentators on Aristotle, are thus translated by Mr Harris in his Hermes.—“Now, what fancy or imagination is, we may explain as follows: We may conceive to be formed within us, from the operation of the senses about sensible subjects, some impression (as it were), or picture in our original sensorium, being a relict of that motion caused within us by the external object; a relict which, when the external object is no longer present, remains, and is still preserved, being as it were its image; and which, by being thus preserved, becomes the cause of our having memory. Now such a sort of relict, and (as it were) impression, they call *fancy or imagination* (E).” A passage from ALCINOUS of the doctrines of Plato, as rendered into English by Dr Reid†, shows, that in this theory, as in that of perception, the Platonists agreed with the Peripatetics. “When the form or type of things is imprinted on the mind by the organs of the senses, and so imprinted as not to be deleted by time, but preserved firm and lasting, its preservation is called *memory*.”

Mr Harris, who was deeply read in the ancient philosophy, and who considered the authority of Aristotle and Plato as superseding all reasoning and all inquiry, after justly observing, that if the soul had no other faculties than the senses it could never acquire the least idea of *time*, thus expresses himself on the subject before us:—“But happily for us we are not deserted here. We have, in the first place, a faculty called *imagination* or *fancy*; which, however as to its *energies* it may be subsequent to sense, yet is truly prior to it both in *dignity* and *use*. This it is which retains the fleeting forms of things, when things themselves are gone, and all sensation is at an end. That this faculty, however connected with sense, is still perfectly different, may be seen from hence. We have an *imagination* of things that are gone and extinct; but no such things can be made objects of *sensation*. We have an easy command over the objects of our *imagination*, and can call them forth in almost what manner we please; but our *sensations* are necessary when their objects are present, nor can we control them but by removing either the objects or ourselves. As wax would not be adequate to its business of signature, had it not a power to retain as well as receive; the same holds of the SOUL, with respect to *sense* and *imagination*. SENSE is its *receptive* power; IMAGINATION its *retentive*. Had it sense without imagination, it would not be as wax but as water; where, though all impressions may be instantly made, yet as soon as made they are entirely lost. Thus then, from a view of the two powers taken together, we may call SENSE (if we please), a *kind of transient imagination*; and IMAGINATION, on the contrary, a *kind of permanent sense*.”

Great part of the office which is here given to imagination, is in common English attributed to memory; but between these two faculties, as well as between them and recollection, the author accurately

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The Peri-
patetics and
Platonists† Essays on
the Intellec-
tual Powers
of Man.58
distinguish
properly
between
imagina-
tion and
memory,
&c.

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distinguishes thus:—"When we view some *relict* of sensation reposed within us, *without thinking of its rise, or referring it to any sensible object*, this is FANCY or IMAGINATION. When we view some such *relict*, and *refer it withal to that sensible object which in time past was its cause and original*, this is MEMORY. Lastly, the *road which leads to memory through a series of ideas however connected, whether rationally or casually*, this is recollection."

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Objections
to their
theory.

Of this theory we shall only remark, that if we could understand the words *picture* and *form* in a metaphorical sense, as candor obliges us to understand Locke's *images* in the mind, the doctrine of *Alexander Aphrodisiensis* would be very little wide of the truth. Experience teaches us that memory as well as perception depends upon the state of the brain; and as it is undeniable, that when a man to-day contemplates an object which he perceived yesterday, or at any former period, he has a view of it in all respects similar to the original perception, only fainter and less distinct, it is extremely probable, that an impression *ab extra*, which produces a sensation and perception, leaves behind it some *tendency* in the brain, to vibrate as in the actual sensation, and that this *tendency* is carried into effect by the internal energy of the mind itself. But in the Peripatetic philosophy, *pictures* and *forms* in the *sensorium* were considered as real things, and by no means as metaphorical expressions. This is evident from their being constantly compared to the impression of a seal upon wax, and from their converting the *materia prima* from something, which can neither be seen nor felt, into visible and tangible body, of which we shall treat afterwards. Now it being certain that on a being immaterial, no corporeal *form* can be impressed, and repeated dissections having shown that no such forms are in fact impressed on the brain, this whole theory is at once overturned.

[59]
Locke's
doctrine
concerning
memory.

Modern philosophers having denied that there are real *images* or *forms* in the mind during the immediate act of perception, cannot consistently with themselves admit such images in the act of retention, or when those things which were formerly objects of perception are recalled to the mind by the power of memory. Mr Locke's doctrine is, that "the mind retains these simple ideas which it first received from sensation or reflection, two ways: first, by keeping the idea, which is brought into it, for some time actually in view, which is called CONTEMPLATION: and secondly, by the power which we have to revive again in our minds those ideas, which, after imprinting, have disappeared, or have been, as it were, laid out of sight; as when we conceive heat or light, yellow or sweet, the object being removed. This (he says) is MEMORY; which is, as it were, the store-house of our ideas †.

† *Essay*,
Book ii.
chap. 10.

To explain this more fully, he immediately adds the following observation:—"But our ideas being nothing but actual perceptions in the mind, which cease to be any thing when there is no perception of them, this laying up of our ideas in the repository of the memory, signifies no more but this, that the mind has a power, in many cases, to revive perceptions which it has once had, with this additional perception annexed to them, that it has had them before. And in this sense it is, that our ideas are said to be in our memories, when indeed they are actually no-

where; but only there is an ability in the mind, when it will, to revive them again, and, as it were, paint them anew on itself, though some with more some with less difficulty, some more lively and others more obscurely. And thus it is, by the assistance of this faculty, that we are said to have all those ideas in our understandings, which, though we do not actually contemplate them, yet we can bring in sight, and make appear again, and be the objects of our thoughts, without the help of those sensible qualities which first imprinted them there."

To attempt a defence of the accuracy of this language would be vain; but as the author's meaning is sufficiently obvious, his expressions may be easily and certainly corrected. Had Locke said—"But our ideas being nothing but scenes or appearances in the mind, which cease to be any thing when there is no perception of them, this laying up of our ideas in the repository of the memory signifies no more but this, that the mind has a power, in many cases, to revive scenes which it has once viewed, with this additional perception annexed to them, that it has viewed them before;" there would have been no room for the many petulant remarks which have been made upon the passage.

But against this account of memory, a much heavier charge has been brought than that which regards the propriety of the language. It has been said, that the additional perception, which, according to Locke, attends the revival of our ideas by the power of memory, "would be a fallacious perception, if it led us to believe that we had them before, since they cannot have two beginnings of existence: nor can we believe them to have two beginnings of existence; we can only believe that we had formerly ideas or perceptions very like to them, though not identically the same." Let us examine this question somewhat narrowly: for if it be really true, that in the sense in which the word *same* is here used, we cannot twice contemplate the same idea, all confidence in memory would seem to be at an end.

Suppose a man to stand on some of the rising grounds about Edinburgh, the Calton-hill for instance, and from that eminence to view the glorious prospect of the coast of Fife, the ocean, the frith of Forth, and the little islands scattered in the frith. Let him go away, and return next day to the same place, and look the same way: we would ask whether he has the same *view* or *perception* which he had the day before? The man must surely be very captious who would say that he has not: and yet it is certain that the energy of mind by which he perceives on one day cannot be identically the same with that by which he perceived on another; nor are the rays of light which fall upon his eyes on the second day, identically the same with those which fell upon his eyes and occasioned vision on the first day. Let the same man now shut his eyes, and contemplate the various objects at which he had been just looking. They will appear to him in all respects the same as when viewed by means of his organs of sight, only fainter and less distinct, with this additional conviction, that the immediate objects of his present contemplation are not real external things, but *ideas* or *mental representations* of those things which had so lately been the objects of his sight. Let him think no more about the matter for

Retention
and Ideas.60
objected to.61
The objec-
tion obvi-
ated.

Retention
and Ideas.Retention
and Ideas.

some days, and then exert his power of memory. We have no hesitation to say, that in the sense of the word *same*, as used by Mr Locke, the very same ideas will recur and be present to his intellect which were present to it at the former contemplation. The second energy of memory or imagination, or whatever it may be called, is not indeed identically the same with the first; nor is that agitation or motion, or whatever other affection of the brain is necessary to memory, identically the same at the second time as at the first: but the mind exerting itself in the very same manner at the one time as at the other, produces the same kind of agitation in the brain, and is itself affected in the very same way at the second as at the first exertion. Whence it follows, that the second *ideal scene* will be as much the same with the first, as the second *actual perception* is the same with the first; and the two ideal scenes, and the two actual perceptions, are respectively said to be the same with each other, only because they impress the mind with a conviction that they were occasioned by the same external objects.

But though we think Locke's doctrine, with respect to memory, may be thus easily vindicated from the charge of fallaciousness, we must acknowledge that to us it appears not to be of much value. It teaches nothing, but that the mind has a power to retain ideas of those objects which it formerly perceived, and in many instances to recal them as occasion may require. But these are truths known to all mankind, to the clown as well as to the philosopher.

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The opi-
nion of
Hume.

Philosophers in general have paid less regard to the retentive faculties of the mind than to its original powers of perception. Perhaps they imagined, that as memory depends upon perception, and in some respects appears to resemble it, a competent knowledge of the nature of the former faculty would lead to that of the second. Be this as it may, Mr Hume, who was at some pains to detail his notions of perception, has in his Philosophical Essays only dropt concerning memory and imagination a few hints, so loosely thrown together, that, if he had not elsewhere expressed himself with more precision, it would have been difficult to discover his real meaning. According to him, that which is commonly called the *perception of an external object*, is nothing but a strong impression upon the mind; and that which is called the *remembrance of a past object*, is nothing but a present impression or idea weaker than the former. Imagination is an idea weaker than the idea or impression which he calls *memory*. This seems to be a wonderful abuse of language. Impressions are not perceptions; and, if possible, they can still less be called *ideas*, which are but secondary perceptions. It is likewise far from being true, that an idea of imagination has necessarily less vivacity than an idea of memory. We have seen Mr Hume, and have at the present moment an idea of his form and dress: we can likewise imagine to ourselves a centaur;

and though a centaur was never seen, and therefore cannot be an *impression repeated by memory*, our idea of the monster is much more lively and distinct than that of the philosopher.

Dr Reid having observed of memory*, that it is by it we have an immediate knowledge of things past; that it must have an object; that in this respect it agrees with perception, but differs from sensation, which has no object but the feeling itself; and that every man can distinguish the thing remembered from the remembrance of it—proceeds to inquire what memory is? And, “First (says he), I think it appears that memory is an original faculty given us by the Author of our being, of which we can give no account but that we are so made. The knowledge (continues he) which I have of things past by my memory, seems to me as unaccountable as an immediate knowledge would be of things to come (F); and I can give no reason why I should have the one and not the other, but that such is the will of my Maker. I find in my mind a distinct conception and a firm belief of a series of past events; but how this is produced I know not. I call it *memory*; but this is only giving a name to it; it is not an account of its cause. I believe most firmly what I distinctly remember; but I can give no reason of this belief. It is the inspiration of the Almighty which gives me this understanding. When I believe the truth of a mathematical axiom or of a mathematical proposition, I see that it must be so: every man who has the same conception of it sees the same. There is a necessary and an evident connection between the subject and the predicate of the proposition; and I have all the evidence to support my belief which I can possibly conceive. When I believe that I washed my hands and face this morning, there appears no necessity in the truth of the proposition. It might be or it might not be. A man may distinctly conceive it without believing it at all. How then do I come to believe it? I remember it distinctly. This is all I can say. This remembrance is an act of my mind. Is it impossible that this act should be, if the event had not happened? I confess I do not see any necessary connection between the one and the other. If any man can show such a necessary connection, then I think that belief which we have of what we remember will be fairly accounted for: but if this cannot be done, that belief is unaccountable; and we can say no more but that it is the result of our constitution. Our original faculties are all unaccountable: Of these memory is one. He only who made them comprehends fully how they are made, and how they produce in us not only a conception, but a firm belief and assurance, of things which it concerns us to know.”

On this account of memory we shall make no remarks. There is a certain sense of the words, in which every thing which the author has said on the subject is undoubtedly just; and it would be very uncandid to

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(F) If memory depends upon the state of the brain as it has been affected in past perceptions, this appears to us a strange position. Perhaps the excellent author means nothing more, than that it is as unaccountable to us, that impressions on the brain should cause perception, and the vestiges of those impressions should cause remembrance, as how the mind might not perceive things to come without the intervention of impressions on the brain. If this be his meaning, no man will controvert it: for it is impossible to discover the nature of that relation which subsists between an impression and perception; but that there is such a relation, we know from experience.

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and Ideas.Retention
and Ideas.

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The appearance of sensible objects when recalled by the power of memory.

* Appendix to Elements of Criticism.

take his words in any other sense. But though memory, as it is the result of that constitution which was given us by God, and not the offspring of habit or human contrivance, is unquestionably an original faculty; and though it is therefore impossible to account for it so fully as to silence every inquiry which may be made; yet we could wish that Dr Reid had bestowed a little more pains upon it, in order to discover if possible in what respects it resembles or differs from perception. He has well observed, that there are laws of nature by which the operations of the mind are regulated, as well as laws of nature which govern the material system. As the latter are the ultimate conclusions which the human faculties can reach in the philosophy of bodies, so the former are the ultimate conclusions which we can reach in the philosophy of minds. The more general that these laws are in both cases, the more useful they are and the more satisfactory: for as they are themselves inexplicable, the fewer they are in number, and the more comprehensive each, the fewer will those phenomena be for which we can give no account. Thus, as we know not what makes the planets tend to the centre of the sun, or heavy bodies tend to the centre of the earth, we can give no other account of these phenomena, but that, as they appear to be of the same kind, it is reasonable to conclude that they proceed from similar causes. What the cause is of this tendency of bodies towards each other, we know not. We call it *gravitation*, and employ it to account for all phenomena of the same kind. In like manner it is universally allowed, that as we know not how mind and matter operate upon each other, there is something in perception wholly unaccountable. That perception follows sensation; and that there is no sensation which is not occasioned by some affection of the brain, proceeding from some impression *ab extra*; we have the evidence of experience: but how a particular affection of the brain should excite a sensation in the mind, we know not; though we may here, as in the corporeal system, attribute similar effects to the same or similar causes. Thus, if when we exert an act of memory we have the same appearance of things as in the original act of perception, the rules of philosophizing authorise us to refer both phenomena to the same general law; just as they authorise us to refer the motion of the planets and of projectiles to the same general law. On the other hand, if we perceive no similarity between memory and perception, we have made no progress in the philosophy of mind; for in that case we have discovered two phenomena proceeding from two causes totally different from each other, and both inexplicable. Although we scarcely hope to throw any light upon a subject which Dr Reid has not attempted to illustrate, we shall state a few facts respecting the memory, and submit to the reader the conclusions to which we think these facts lead.

1. Objects once perceived by the senses, when recalled to the mind by the power of memory, appear

precisely the same as in the original perception, only less distinct*. For example, having seen yesterday a spreading oak growing on the bank of a river, and having heard a shepherd play, and handled a square stone, we endeavour to recal to our minds these objects which are now absent. How is this operation performed? Do we endeavour to form in our minds pictures of them or representative images? or, does our intellect survey the types or forms which, according to Aristotle, those objects left in the imagination when originally perceived? Neither of these things is done. We conceive ourselves as standing in the same place where we stood yesterday; upon which we have perceptions of the objects similar in all respects to the perceptions which we had when we employed our eyes, our ears, and our hands. The tree appears, as it were, before us; faint indeed, but attended with all the objects which we observed around it yesterday: we seem to hear the sound of the pipe confusedly, and at a distance; to move our hands over the stone, and to feel the same surfaces and the same angles which we felt in the original perception. In this recollection we are not conscious of pictures or images more than in the original survey. The perceptions seem to be of the tree and river themselves, of the sound itself, and of the stone itself, exactly as at the first; and yet we are satisfied that in the act of remembrance we perceive no such object as a *real* tree, pipe, or stone. That these are facts, every man must be convinced who attends to the energies of his own mind when exerting the powers of retention: and therefore it is, in our opinion, with no impropriety that Mr Harris says, we may call *SENSE*, if we please, a *kind of transient imagination*; and *IMAGINATION*, on the contrary, a *kind of permanent sense*: for if these two faculties, as far as the mind or intellect is concerned, be not the same, they seem to resemble each other much.

2. The *primary* perception of a *visible* object is more complete, lively, and distinct, and remains longer in the *sensorium*, than that of any other object. We know likewise by experience, that an *idea* or *secondary* perception of a visible object is as much more complete, lively, and distinct, than the idea of any other object, as was the *primary* perception; and that we remember things which we have seen for a longer time than sounds which we have heard, or than tangible objects which we have only handled. Yet there seems to be a constant decay of all our ideas, even of those which are struck (G) deepest and in minds the most retentive; so that if they be not frequently renewed by repeated exercise of the senses, or by reflection on those objects which at first occasioned them, the print (G) wears out, and at last there remains nothing to be seen. Concerning ideas, it is easy to remark, that those remain longest and clearest in the memory which are derived from two or more senses, especially if the sense of sight be one of the number, or which are oftenest refreshed by a return of the objects which produced them. Hence a man has a longer and more distinct remem-

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What ideas remain longest in the memory.

(G) These expressions, which mention ideas as things which are *deep struck*, and as *prints which wear out*, are the expressions of Locke. We hope it is needless to warn our readers, that they are used by us as they were by him in a metaphorical sense. On these subjects it is impossible to write without metaphor; which, while the meaning is obvious, no man will condemn, who reflects that the words of language were not invented by metaphysicians, and are for the most part *literally* significant only of sensible objects.

Retention
and Ideas.Retention
and Ideas.66
Memory a
kind of ha-
bit.* Reid's Ef-
fays on the
Intellectual
Powers of
Man,
Locke's Ef-
fay, &c. and
Harris's
Hermes.67
In recollec-
tion one
idea sug-
gests ano-
ther, and
why.† Hartley on
Man.

remembrance of what he has seen than of what he has only heard, of what he has both seen and felt than of what he has only seen; and the ideas which we have of heat and cold, of hunger and thirst, and of all those things which most frequently affect our senses, are extremely clear, and are never quite lost whilst the mind retains any ideas at all.

3. Memory appears to be a kind of habit, which is not always in exercise with regard to things we remember, but is ready to suggest them when there is occasion. The most perfect degree of this habit is, when the thing presents itself to our remembrance spontaneously, and without labour, as often as there is occasion. A second degree is, when the thing is forgotten for a longer or shorter time, even when there is occasion to remember it, and yet at last some incident, such as a violent passion*, which agitates the whole mind and sensorium, tumbles the idea, as it were, out of its dark corner, and brings it into view without any search. A third degree is, when we cast about and search for what we would remember, and after some labour find it out. This searching faculty of the soul is by Aristotle called *αναμνησις*, by Dr Reid and others *remembrance*, and by Mr Harris *recollection*. Should it be said, that what we *will* to remember we must already conceive, as we can will nothing of which we have not a conception; and that, therefore, a *will* to remember a thing, seems to imply that we remember it already—we answer, with Dr Reid, that when we will to remember a thing, we must indeed remember something relating to it; but we may have no positive idea or conception of the thing itself, but only of the relation which it bears to that other thing which we do remember. Thus, one remembers that a friend charged him with a commission to be executed at such a place, but he has forgotten what the commission was. He applies himself to discover it; and *recollects* that it was given by *such a person*, upon *such an occasion*, in consequence of *such a conversation*: and thus by a train of thought he is led to the very thing which he had forgotten and wished to remember. To this operation it is not always necessary that the relations between the various ideas which the mind turns over be very close, or have their foundation in nature; for a casual connection is often sufficient. Thus, from seeing a garment, we think of its owner; thence of his habitation; thence of woods; thence of timber; thence of ships; thence of admirals; thence of cannons, iron, furnaces, and forges, &c."

That, in the process of recollection, one idea should suggest another, may be easily accounted for. When, in perception, our minds are exposed to the influence of external objects, all the parts and properties, and even the accidental variable adjuncts of these objects, are perceived by full-grown men at the same time; so that the whole group makes but one impression upon our organs of sense, and consequently upon the mind. By these means all the parts of the simultaneous impression †, and consequently of the perception occasioned by that impression, are so intimately associated or linked together, that the idea of any one of them

recurring at any future period, generally introduces the ideas of all the rest. But as the necessary parts and properties of any thing are more closely linked together, and occur more frequently than any particular variable adjuncts, it is obvious, that by the idea of any one of these properties, the idea of the rest, and of the object itself, will be more readily introduced than by the idea of any variable adjunct. It seems, however, to be certain, that we have no power of calling up any idea at pleasure, but only such as have a connection, either in nature or by means of former associations, with those that are at any time present to the mind. Thus the sight, or the idea, of any particular person, generally enables us to recollect his name, because his name and his person have been constantly associated together. If that fail to introduce the name, we are at a loss and cannot recollect it at all till some other associated circumstance help us. In naming a number of words in a sentence, or lines in a poem, the end of each preceding word or line being connected with the beginning of the word or line which succeeds it, we can easily repeat them in that order; but we are not able to repeat them backwards with any ease, nor at all till after many fruitless efforts. By frequent trials, however, we acquire at last a facility in doing it, as may be found by making the experiment on the names of number from one to twenty. It is, indeed, probable, that in the wildest flights of *fancy*, no single idea occurs to us but such as had a connection with some other idea, perception, or notion, previously existing in the mind, as shall be shown more fully in a subsequent chapter.

4. "Memory appears to depend entirely or chiefly upon the state of the brain*. For diseases, concussions of the brain, spirituous liquors, and some poisons, impair or destroy it; and it generally returns again with the return of health, from the use of proper medicines and methods. It is observable, too, that in recovering from concussions and other disorders of the brain, it is usual for the person to recover the power of remembering the then present common incidents for minutes, hours, and days, by degrees; also the power of recalling the events of his life preceding his illness. At length he recovers this last power perfectly; and at the same time forgets almost all that past in his illness, even those things which at first he remembered for a day or two. Now the reason of this seems to be, that upon a perfect recovery the brain recovers its natural state, and all its former affections and tendencies; but that such affections or tendencies as took place during the preternatural state, *i. e.* during the patient's illness, are obliterated by the return of the natural state." All this we are induced to believe; because, though it is a fact incontrovertible, that in certain diseases the memory is impaired, and recovers its vigour with the return of health, it is not conceivable that the mind itself should suffer any change by diseases, concussions, or spirituous liquors, &c.

From these facts we are strongly inclined to conclude, that the power of the *mind*, or *immaterial* (H) *principle*

(H) Through the whole of this and the preceding chapters, we have taken it for granted that the sentient principle in man is not material. This is the *common*, and, as shall be shown afterwards, the most *probable* opinion; but whether it be absolutely certain or not, makes no difference on the theories of sensation and perception. These are obviously neither figure nor motion, and therefore not subject to the laws which govern the material world.

Retention
and Idea.Retention
and Idea.69
External
objects operating
on the senses
leave some
permanent
effect in the
brain.

principle, by which it remembers past events, differs not from that by which it perceives present objects. In perception, impressions are made upon the organs of sense, which are communicated to the brain; and, by some unknown means, occasion sensations which are followed by the perception of the external object. When by the power of memory we recal past objects of sense, the mind has the same view of them as in the original perception, except that they appear fainter, less distinct, and generally more distant. We have, therefore, reason to conclude, that in the act of remembrance the brain is affected in the same way, though not so forcibly, as in perception. That memory depends as much as perception upon the state of the brain, is confirmed by daily experience; and therefore there cannot be a doubt but that external objects, operating upon the senses, nerves, and brain, leave some permanent effect behind them. What that effect precisely is we cannot know, and we need not desire to know; but that they leave *some* effect we have as good evidence as that the planets are moved round the sun by forces of the same kind with those by which projectiles are moved on the earth. Could we suppose that they leave real *prints* or *impressions* behind them, which we confess to be very little probable, memory would seem to be nothing but the perceptive power of the mind turned to those impressions. If the permanent effect of impressions by external objects be, as Dr Hartley supposes, only a tendency in the brain to vibrate as in the original perception, remembrance will result from the mind's operating upon the brain as in actual perception; and the reason that ideas of memory are fainter than perceptions of sense, is, that the former are produced by a single, and the latter by a double, operation.

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Why the
memory
advances to
perfection,
and then
gradually
decays.

This theory appears to be greatly confirmed by the following well-known facts, that children soon commit to their memory any thing which they understand, and as soon forget it; that the powers of memory gradually advance to perfection, and then gradually decay; and that old men remember more distinctly what they perceived in their youth, than what they perceived a year ago. For if the memory belonged wholly to the pure intellect, and had no dependence upon the brain, it is not easy to conceive how it should advance towards a state of perfection and afterwards decay. A being which is unextended and indivisible, can suffer no change either in its essence or in its faculties: the ideas which it had once retained, it would retain forever. But if memory be occasioned by some relict of sense left in the brain, it is easy to see how all those changes should take place: and therefore, though we have the weight of Dr Reid's authority against us, we cannot help thinking that Aristotle was in the right, when he imputed the shortness of memory in children to this cause, that their brain is too moist and soft to retain impressions made upon it; and that he was likewise in the right, when he imputed the defect of memory in old men to the hardness and rigidity of the brain, which hinders it from receiving any durable impression.

Another argument to prove, that in remembrance the mind acts upon something left in the brain by the impressions of sense, is this, that nothing can act

but where it is present. The truth of this axiom is acknowledged by Dr Reid, and we believe by all mankind except Dr Priestley and one or two others, whose paradoxes we shall consider afterwards. Now it is confessed, that in recollection at least the mind is active; and therefore it must act, *not* upon an object which has now perhaps no existence, and certainly no immediate existence, *but* upon something left by that object in the brain or sensorium, to which the mind is intimately present.

But if this be so, we may be asked how it comes to pass that men never confound memory with perception, nor fancy that they perceive things which they only remember? If perception be an inference drawn from certain sensations excited by an impression on the brain, and if remembrance result from the mind's operating upon relicts of those impressions, one would think it natural to suppose, that in both cases we have actual perceptions, though in the one case the perception must be more vivid and distinct than in the other. To this we answer, That previous to all experience, perception and memory are very probably confounded; and that we believe a man brought into the world with all his faculties in their full *natural* perfection, would not instantly be able to distinguish what he remembered from what he perceived. This we know to be the case with respect to imagination, a faculty which strongly resembles memory; for in dreams, and sometimes even in waking reveries, we fancy that we actually perceive things which it is certain we can only imagine. A very short experience, however, would enable this newly created man to make the proper distinction between remembrance and perception. For let us suppose him to be brought into a dark room, and soon afterwards a candle to be introduced. The candle would give him a visible sensation, though not at first the perception of an external object. Let the candle after some time be carried out: the man would retain a visible *idea*, which he might confound with the actual sensation. But if, whilst this idea remained in his mind, the candle were brought back, he would instantly feel a difference between the real sensation and the idea, when both were together present to his mind. And having, in some such manner as we have already described, acquired the power of perceiving external objects by means of his senses, he would soon discover, without any effort of his own, the difference between actual perceptions and the ideas treasured up in his memory.

The only remaining difficulty which seems to embarrass this theory of remembrance, is, to account for the order of succession in which objects recur to the memory, and to which we give the name of *time*. But this difficulty will vanish when we have ascertained what *time* is. At present it is sufficient to observe, that our perceptions of external objects remain a certain space of time in the mind; that this time is different, according to the strength and other circumstances of the impression which occasioned the perception; and that traces of those perceptions, *i. e.* *ideas*, may be recalled after the intervention of other trains of ideas, and at very different intervals. If one look upon a house, and then shut his eyes, the impression which it made upon his mind will not instantly vanish:

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By what
means we
never con-
found me-
mory with
perception.72
The order
of succes-
sion in
which ob-
jects recur
to the me-
mory.

Retention
and Ideas.Retention
and Ideas.73
Brutes have
memory,
and

nish: he can contemplate the house almost as long as he pleases; and, by the help of various associated circumstances, he may recal the idea several years afterwards, and refer it to the original perception.

Before we dismiss the subject of retention, it may not be improper to take notice of the retentive powers of inferior animals. Aristotle, Locke, Dr Reid, and almost every philosopher of eminence both among the ancients and moderns, have maintained, that inferior animals have memory as well as men; and indeed we do not perceive how the fact can be denied of the more perfect animals, and those with whose operations we are best acquainted. A dog knows his master again after a long absence; a horse will trace back a road which he has but once travelled, often with more accuracy than his rider; and it is well known that many species of singing birds have a capacity to learn tunes from the human voice, and that they repeat the notes again and again, approaching nearer and nearer to perfection, till at last they sing the tune correctly. These phenomena can be accounted for only by supposing, that in the brains of the several animals traces are left by perception, of the same kind with those which perception leaves in the brain of man, and which are the cause or occasion of his remembrance. With respect to this point, the learned author of *Ancient Metaphysics* differs from his master Aristotle. He allows that brutes have imagination, but denies that they have memory: for (says he) "memory necessarily implies a sense of time, and what is *first* and *last*; but brutes have no idea of time, or of first and last; and it is certain that they have not consciousness or reflection, by which only they could review their own operations. At the same time he admits, that imagination in the brute serves the purpose of memory in us; for whenever he sees the object that is painted on his *phantasia*, he knows it again, but without any perception of the time when he first saw it." But that a brute, when he sees the object which is painted on his *phantasia*, should know it *again* without referring it to a former perception, is plainly impossible. The recognisance of any thing consists in a consciousness of its having been perceived before; and nothing more than such recognisance is essential to memory. The author's mistake seems to lie in supposing that memory necessarily implies a sense of some determinate portion of past time; but we surely remember many things of which we can only say that we have formerly perceived them, without being able to ascertain the precise period at which we had such perceptions. A child has the use of memory sooner than he acquires the faculty of speech; but he must have spoken and even reasoned before he can have an accurate notion of time, which, as shall be shown afterwards, arises from comparing the fleeting succession of our own ideas with the permanence of ourselves and other objects. The author's distinction between memory and imagination seems to be on all accounts improper. Aristotle has said, and said truly, that there is memory of *ideas* as well as of sensible objects; meaning by ideas general conceptions or propositions: but this reviver of his philosophy is inclined to say, "that memory is only of *ideas*, consequently belongs only to man; and that *imagination* is only of sensible objects, and consequently belongs both to man and brute."

But surely man *remembers* what he has *seen* and *felt* as well as what he has *conceived* or *thought*; and if imagination and memory be properly distinguished by Mr Harris, the reverse of this writer's doctrine must be true, viz. that imagination belongs only to *man*, and memory of sensible objects both to *man* and *brute*.—We can contemplate in imagination the idea of a *centaur* or a *golden mountain*; but we cannot be said to remember them, for they were never perceived. That a dog can contemplate in his imagination the idea of a *centaur* or of a *golden mountain*, we have not the least reason to suppose; but were he not capable of viewing reliëts of sense reposed within him, and referring them to their original causes, he could not possibly recognise his master after a day's absence.

Dr Reid and the same author agree with Aristotle, in thinking it probable that brutes have not reminiscence, or the power of recollection; but there are many well attested facts which seem to prove the contrary. We shall mention one which fell under our own observation. One of the persons concerned in this work was, when a young man, absent for five months from the house of his father. Upon his return, a dog of that species which is commonly called the *shepherd's cur*, and which had been in the possession of his father only a few months before his departure, gazed at him for a few minutes as at any other stranger. The animal then began to walk round him with looks which soon attracted his notice. This made him call the dog by the name which he bore in the family, and stretch out his hand to caress him, when the creature instantly leaped upon him with all that appearance of attachment which those animals so commonly exhibit upon the return of their master after a few days absence. If this was not recollection, we should be glad to know what it was, for we cannot distinguish it from recollection in men. Indeed, if dogs and some other animals possess, as Aristotle, Locke, and others, allow them to possess, the power of memory, and something of ratiocination; and if, as Dr Reid expressly says §, "they expect events in the same order and succession in which they happened before;" it is not conceivable that they can be wholly destitute of reminiscence, or the power of recollection.

That memory is a faculty of the first importance, cannot be denied; since it is obvious, that, without the power of retaining the ideas and notions which we receive by the senses and other faculties, we never could make any progress in the acquisition of knowledge, but should begin every day, nay every hour, in the same state of ignorance in which we are born. That it is a faculty capable of improvement by exercise, and that there are some methods of exercise better adapted for this purpose than others, has been shown elsewhere. See MEMORY.

CHAP. III. Of SIMPLE APPREHENSION and CONCEPTION.

THE ideas received into the mind by the senses, and treasured up in the memory and imagination, are the original materials of human knowledge. It is by comparing those ideas with one another, or by analysing them into their first principles, that we acquire all our knowledge in mathematics and philosophy, and

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the power
of recollec-
tion.75
Memory
capable of
improvement.76
Ideas of
sensation
the first ma-
terials of
human
knowledge.

Of Simple
Apprehen-
sion and
Conception

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Simple ap-
prehension
of ideas

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Different
from con-
ception.

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In what
sense it is
true that
we can con-
ceive ob-
jects which
never ex-
isted.

and indeed all the knowledge which regulates our conduct through life. It must, therefore, be of importance to trace the progress of the mind in her various operations upon these materials; beginning, as she certainly begins, with that which is most simple, and proceeding regularly to those which are more complex and difficult.

Now the first operation of the mind about her ideas appears plainly to be that which logicians term *simple apprehension*. Having yesterday observed a tree or any other object, if we contemplate the idea of that tree to day as it remains in the imagination, without comparing it with any other idea, or referring it to any external object, we perform the operation which is called *simple apprehension*. We consider simple apprehension as an *operation*, because the mind in the apprehension of her own ideas is certainly active; she turns them, as it were, round and round, and views them on every side.

Simple apprehension is a phrase which is commonly taken to be of the same import with the word *conception*; and in the ordinary affairs of life no confusion can arise from an indiscriminate use of the two words: but in this article we think it expedient to employ the phrase *simple apprehension*, to denote the view or contemplation of those ideas only which the mind by sensation has actually received from external objects; and the word *conception* to denote the view, not only of those ideas, but also of such as the mind fabricates to herself. Thus, a man may *conceive* a centaur, but we would not choose to say that he may *apprehend* a centaur: not that there is any impropriety, perhaps, in this last expression; but as there is certainly a difference between *apprehending* the idea of what has been seen or felt, and *conceiving* that which never existed, perspicuity requires that these different operations be expressed by different names.

We have said that the mind may conceive what never existed; and every man may easily satisfy himself that what we have said is true: but though this has been frequently called the creative power of the mind, it has in fact no resemblance to *creation*. The materials of all our most complex and fantastic conceptions are furnished to our hands by sensation and reflection; nor can we form one simple idea which was not originally received by some of our senses from external objects, or, as shall be shown afterwards, one intellectual notion which was not acquired by reflecting on the operations of our own minds. To explain the process of fantastic conception, it is to be observed, that in every sensible object we perceive at once several things, such as *colour*, *figure*, *extension*, and *motion* or *rest*, &c. These are the objects of different senses: but they are not, at least by full grown men, perceived in succession, but all at once; whence it comes to pass that the memory, or the imagination, retains not several distinct and disjointed ideas, but the idea of *one coloured, figured, and extended object*. But when we compare various objects, or the ideas of various objects, together, we find that in some respects they agree and in others disagree; *i. e.* that several objects affect some of our senses in the same way, and other senses differently. Thus one globe is black, and another white; one black substance is circular and hard, and another square and soft. In the first in-

N^o 213.

stance, the two globes affect our sense of touch in the same way, and our sense of seeing differently; in the second, the two black substances affect our sense of sight in the same way, and our sense of touch differently.

From observing this difference among objects by means of the different sensations received from them, the mind learns to analyse its original ideas, which are copies of those sensations, into their first principles, and to combine those principles in such a manner as to form complex ideas of objects which were never actually perceived by the senses. Of the simple and unmixed principles which compose those complex ideas, there is not indeed one which was not originally received by some sense; so that the whole difference between complex ideas fabricated by the mind, and those which are the reliëts of sensation, consists in the order in which the constituent simple ideas of each are put together. Thus, no man ever saw a mountain of pure gold; and therefore the idea of such a mountain can be in no human mind as a reliëct of sensation: but we have all seen pieces of gold of different sizes, and we have all seen mountains; and nothing is more easy than to *conceive* a piece of gold extended on all sides to the size of a mountain, and rising out of the earth. Again, though no person ever saw a centaur, yet it is easy to *conceive* the upper parts of a man joined to the breast and shoulders of a horse. In these instances, the complex conceptions are of things which it is in the highest degree probable never had a real existence, and which it is certain we never *perceived* as existing: but the simple ideas of which they are composed are the reliëts of actual sensations; for every one has perceived as really existing the body of a horse and the upper parts of a man, and when conceiving a centaur he only perceives them to exist united. That we have not in the imagination one simple and unmixed idea which was not left there as a reliëct of sense, every man will be convinced who shall try to conceive a simple colour or taste which is totally different from all the colours and tastes, and all the shades and varieties of them, which he has received by sensation; but his simple ideas, though all received from without, he may put together in numberless manners, differing from any order in which he has ever actually perceived the qualities of external objects existing.

Yet even this power of the mind is limited. It is impossible to put together a number of *contrary* and *inconsistent* ideas, in such a manner as to form of them one complex conception. No man, for instance, can conceive a thing to be at once white and black, round and square, hard and soft, in motion and at rest.—Hence it is a maxim among philosophers almost universally received, that though we can conceive many things which never *actually* existed, yet we can form no ideas but of such things as *might possibly exist*. A centaur never existed, but it may be conceived; for it is by no means impossible that the head of a man might be joined to the body of a horse: but black snow cannot be *conceived*; for in the complex idea denoted by the word *snow* whiteness is an essential part, and nothing can be conceived to be both black and white at the same time. From this undoubted fact, that we cannot conceive impossible existence, the power of conception has by some writers in certain instances been made a test of truth. “In every idea is implied

Of Simple
Apprehen-
sion and
Conception

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This power
of excep-
tion limited
to possi-
ble exist-
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I

(says

Of Simple
Apprehen-
sion and
Conception

* Review of
the principal
Questions and
Difficulties in
Metaphysics.

† Essays.

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The singular
opinion
of Dr Reid
respecting
our power
of concep-
tion

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contro-
verted.

(says Dr Price*) the possibility of the existence of its object; nothing being clearer, than that there can be no idea of an impossibility, or conception of what cannot exist." "It is an established maxim in metaphysics (says Hume), that whatever the mind conceives, includes the idea of possible existence; or, in other words, that nothing we imagine is absolutely impossible †." In a word, it has been admitted by all philosophers, from Pythagoras to Dr Reid, to be an axiom as evident and undeniable as any in Euclid, that whatever we can distinctly conceive is possible, though many things may be possible, nay, may really exist, of which we can form no conception.

This axiom has been denied by the author of the *Essays on the Intellectual Powers of Man*; who affirms, that "any two sides of a triangle may be conceived to be equal to the third," as distinctly as "any two sides of a triangle may be conceived to be greater than the third." This assertion from such a man surprised us as much as any paradox which we ever read: for nothing is more certain, than that *we* ourselves can form no conception of a triangle of which two of the sides are only equal to the third. We can, indeed, resolve the proposition into its different parts, and form the distinct and independent ideas of a *triangle*, *two sides*, and *one side*; and we can likewise form the general notion of *equality*: but to combine these ideas and this notion into one individual complex conception, we find to be absolutely impossible. A man who knows nothing of triangles, if such a man there be, might believe Dr Reid that it is a figure of which one of its sides is equal to the other two; but such a person would have no *conception* of the *figure itself*, but only a confidence in the Doctor's veracity.

What is it to *conceive* a corporeal thing to exist? Is it not to fancy that we view it on all sides, as what may be seen, or felt, or smelt, or tasted? The Doctor, indeed, repeatedly reprobates as the source of much error the notion of ideas as images in the mind; and if ideas be taken as real material figures, he is certainly in the right: But we appeal to the common sense of mankind, whether every person who distinctly *conceives a triangle*, is not at the time conscious that his mind is affected in a manner similar, though not so forcibly, as when he actually views a triangle with his eyes? What other men may feel, they know best; but we are as certain that this is the case with respect to ourselves, as we are certain of our own existence. That this affection of the mind is occasioned by some agitation in the brain, of the same kind with that which

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occasions actual perception, is highly probable; but whatever be the cause, the fact is undeniable.

The Doctor's words indeed, taken by themselves, would lead one to think, that by *conception* he means in this case nothing more than the understanding of the terms of a proposition: but if that be his meaning, there was no room for controversy; as the great philosophers *Cudworth*, *Clarke*, *Price*, and *Hume*, whose opinion he is combating, would have been as ready as himself to allow, that when a man is thoroughly master of any language, he will find no difficulty in understanding the meaning of any particular words in that language, however absurdly these words may be put together.* When Dr Price says, that "in every idea is implied the possibility of the existence of its object, nothing being clearer than that there can be no idea of impossibility or conception of what cannot exist," his meaning evidently is, that we cannot mentally contemplate or fancy ourselves viewing any thing corporeal, which we might not actually view with our eyes, or perceive by some other sense (1). This is the true meaning of *conception*, which is something very different from understanding the separate meaning of each word in a proposition.

The learned professor, however, appeals to the practice of mathematicians for the truth of his opinion: and if they be on his side we must give up the cause; for in no science have we such clear ideas, or such absolute certainty, as in mathematical reasonings. But it is to be observed, that the word *conception* is with no propriety applied to *abstract truth*, but to *real* or *possible* existence; nor can we be said to conceive distinctly a *real* or *possible* object, unless we be able to turn it round and round, and view it on all sides.—The faculties which are conversant about *abstract truth* are the judgment and the reason; and truth itself consists in the agreement, as falsehood does in the disagreement, of two or more ideas or terms compared together. If those ideas about which the judgment is to be made can be immediately brought together, without the intervention of a third idea, it is impossible that we should *judge*, or, if Dr Reid will have it so, *conceive* that to be *true* which is *really false*. If the two ideas cannot be immediately brought together, it is impossible that we should form any *judgment* or *conception* at all about their *agreement* or *disagreement*: but we may *suppose* or *admit*, for the sake of argument, that they agree or disagree; and if that supposition conduct to a manifest absurdity, we then *know* that the supposition was false. It is, therefore, perfectly agreeable to

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(1) Dr Price may be thought by some to have contradicted in this passage what he had asserted in a former. He is a strenuous advocate for abstract and general ideas even of material objects: but those among the moderns who contend the most zealously for these, contend for them only as conceptions of the mind which can have no possible existence out of it. Were this likewise the opinion of Dr Price, he would certainly have fallen into a direct contradiction; but this is not his opinion. His notion of abstract ideas seems to be the same with that of Plato, who considers ideas, not only as the possibilities of existence, but as things actually existing from eternity, uncreated and independent even of the Supreme Mind. That Dr Price carries the matter thus far, we are unwilling to believe; but he certainly considers general ideas as real existences independent of *our* minds, though the immediate objects of our understanding. That in this notion he is mistaken, we shall endeavour to prove in the next chapter. It is enough for our present purpose to have shown that he does not contradict himself; and that he might with great propriety affirm on his own principles, as well as upon the principles of those who admit not of universal ideas, that in every idea is implied the possibility of its object.

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the max'm of Price and Hume, that mathematicians should in many cases prove some things to be possible and others impossible, which without demonstration would not have been believed; because if the ideas compared cannot be immediately brought together, no judgment previous to the demonstration can be formed of the truth or falsehood of the proposition; and if it concern not real or possible existence, it is a proposition with which *conception* has nothing to do.

"But (says Dr Reid) it is easy to *conceive*, that, in the infinite series of numbers and intermediate fractions, some one number integral or fractional may bear the same ratio to another as the side of a square bears to its diagonal." We are so far from thinking this an easy matter, that if the word *conceive* be taken in the sense in which it is used by the philosophers whose opinion he is combating, we must confess that we can form no adequate conception at all of an infinite series. When we make the trial, we can only bring ourselves to *conceive* the real numerical figures 1, 2, 3, &c. or the fractional parts $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, &c.; and even here our *conception* reaches but a small way.—We have reason to believe, that minds of a larger grasp can conceive at once more of the series than we can; and that the Supreme Mind conceives the whole of it, if the whole of a mathematical infinity be not a contradiction in terms: but surely no man will say that he can conceive an infinite series as he conceives a centaur, and have an adequate and distinct view of it at once. If, by conceiving that in an infinite series some one number may bear the same ratio to another that the side of a square bears to its diagonal, the Doctor only means that such a *supposition* may be made, his observation is not to the purpose for which it is brought; for the question is not about our power to make suppositions of this kind, but about our power to raise in our imaginations an adequate and distinct mental view of possible or impossible existence. "To suppose (says Johnson), is to advance by way of argument or illustration, without maintaining the truth of the position." In this sense a man may *suppose* that in an infinite series there may be some one number which bears the same ratio to another that the side of a square bears to its diagonal: but such a supposition contains in it nothing that is *positive*, which conception always does; it is only admitting, for the sake of argument, a position, of the truth or falsehood of which the person who makes the supposition knows nothing.—He is only talking of ratios as a blind man may talk of colours. A man born blind may be made to comprehend many of the laws of optics, and may make suppositions about colours, and reason from such suppositions to a certain extent, as clearly and justly as one who sees; but will any person say that a man blind from his birth can conceive *red* or *green*? It is much the same with respect to an infinite series. We can follow such a series so far, and may know the ratio by which it increases or decreases, and reason from what we know with the utmost certainty: but no man ever *conceived the whole of an infinite series* as he conceives an individual object; nor can any reasonings upon the nature of it be applied to the question of conceiving impossible existence.

But "mathematicians often require us (says Dr Reid) to conceive things that are impossible, in order

to prove them to be so. This is the case in all their demonstrations *ad absurdum*. Conceive (says Euclid) a right line drawn from one point of the circumference of a circle to another, to fall without the circle. I conceive this, I reason from it, until I come to a consequence that is manifestly absurd, and from thence conclude that the thing which I conceived is impossible." If it be indeed true, that Euclid desires his readers to conceive a mathematical circle with a line drawn from one point of its circumference to another, and that line lying without the circle—if he really desires them to form such a complex conception as this, we have no hesitation to affirm, that he requires them to do what is manifestly impossible. The writer of this article has not in his custody any copy of the elements in the original Greek, and therefore cannot say with certainty what are Euclid's words, nor is it of much importance what they be; for on a question which every man may decide for himself, by looking into his own mind, the authority of Euclid is nothing.—The proposition to which the Doctor refers, is the second of the third book; and, in the edition of Simpson, is expressed thus: "If any two points be taken in the circumference of a circle, the straight line which joins them shall fall within the circle." Every mathematician who can form an adequate conception of a circle and a straight line, perceives the truth of this proposition instantly, for it results necessarily from his conception; but he who has not an adequate conception of a circle, may stand in need of a demonstration to show him the truth: for it is to be observed, that demonstration does not *make truth*; it only points it out to those who cannot perceive it intuitively, just as a microscope does not make the hairs on a mite's back, but only brings them within the field of vision.

Were a man who never examined a mite through a microscope, and who has no adequate ideas of the insect kingdom, to be asked whether there be hairs on a mite's back? he would probably answer that he did not know, but he could *conceive* no such hairs. In like manner, were a man who has no adequate conception of a mathematical circle, to be asked whether a straight line, which joins any two contiguous points in the circumference, could lie *without* the circle? he would probably answer that he did not know. Now it is to be remembered, that the reader of the Elements can have no very adequate conception of a circle when he comes to the second proposition of the third book. The definition of a circle was indeed given him in the introduction to the first book; but of that definition he has hitherto had occasion to make very little use, so that his idea of a circle will be little more accurate than that of an illiterate clown, who has no other idea of the figure than what he takes from a half-penny or a shilling. Dr Reid himself has elsewhere† well observed, that "when a youth of moderate parts begins to study Euclid, every thing at first is new to him. His apprehension is unsteady; his judgment is feeble; and rests partly upon the evidence of the thing, and partly upon the authority of his teacher: but every time he goes over the definitions, the axioms, the elementary propositions, more light breaks in upon him; the language becomes familiar, and conveys clear and steady conceptions." In this state he cer-
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† See Lord
Kames's
Sketches of
the History
of Man; Appendix
to the first
Sketch on
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tainly is when he reads for the first time the second proposition of the third book: his conception of a circle can then be neither clear nor steady. Our young geometrician, however, must allow, that the proposition is either true or false; and if he has read the preceding books with any advantage, he must have clear and steady conceptions of angles and triangles, and be able to demonstrate many of their properties. "Well (says Euclid), though you have no adequate conception of a circle, you are well acquainted with plane angles and triangles, and many of their properties: let us suppose, if that be possible, that my proposition is false, and I will show you that the supposition is absolutely inconsistent with what you know to be demonstrable or self-evident truth." This is all which Euclid can be supposed to require, when, in the words of his excellent translator, he says, "If it (viz. the straight line) do not fall within (the circle), let it fall, if possible, without." He could not possibly desire a man who has an adequate idea of a circle, to form the positive and complex conception of that figure, with a straight line touching two points of the circumference, and yet lying on the outside of the circumference; because all his figures and lines are mere conceptions, and not real material things; and such a request would have been the same thing as if he had said, Conceive what cannot be conceived (κ).

We have insisted the longer on this point, because we think it of the highest importance: for were it indeed true, that we could conceive impossible existence, the consequences would be very melancholy. These consequences it is needless to enumerate. Our readers will perceive, that if we could put together inconsistent ideas of sensible objects, and view them so united as one consistent whole, nothing is clearer than that our faculties would be contrived to deceive us, and we would be doomed to cheerless and universal scepticism.

CHAP. IV. Of ABSTRACTION and GENERAL IDEAS.

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Every sensible object and every idea are individual.

EVERY sensible object is an individual, and differs in many respects from every other object. As such it is perceived by the senses; and ideas being nothing more than reliëts of sensation preserved in the imagination or memory, every idea must of course be an

individual, as much as the object to which it refers. But all science, whether mathematical, moral, or metaphysical, is conversant about general truths; and if truth consist, as we have already observed, and shall more fully evince afterwards, in the agreement or coincidence of ideas, how, it may be asked, can general truth result from the comparison of particular ideas? To get rid of this difficulty, many philosophers, both ancient and modern, pretend that the mind is furnished with *general ideas*, from a comparison of which result general propositions applicable to many individuals. Philosophers, indeed, have differed in opinion respecting the source of those ideas; some of the ancients deriving them immediately from the supreme mind to the human, whilst almost all the moderns say that they are framed by abstraction, and therefore call them *abstract ideas*.

The doctrine of *abstract ideas* has been so fairly stated, and, in our opinion, so completely overturned, by Bishop Berkeley, that we shall content ourselves with abridging what he has said on the subject, and obviating some cavils which have lately been urged against his reasoning. "It is agreed on all hands (says that learned and ingenious prelate †), that the qualities or modes of things do never really exist each of them apart by itself and separated from all others; but are mixed, as it were, and blended together, several in the same object. But, we are told, the mind being able to consider each quality singly, or abstracted from those other qualities with which it is united, does by that means frame to itself abstract ideas. For example: There is perceived by sight an object extended, coloured, and moved: this mixed or compound idea, the mind resolving into its simple constituent parts, and viewing each by itself exclusive of the rest, does frame the abstract ideas of extension, colour, and motion. Not that it is possible for colour or motion to exist without extension; but only that the mind can frame to itself by *abstraction* the idea of colour exclusive of extension, and of motion exclusive of both colour and extension. Again, the mind having observed, that in the particular extensions perceived by sense, there is something common and alike in all, and some other things peculiar, as this or that figure or magnitude, which distinguish them from one another; it considers apart, or singles out by itself, that

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The doctrine of abstract ideas stated, and

† Introduction to the Principles of Human Knowledge.

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(κ) Principal Campbell, treating of the commonly received doctrine of abstraction, and having shown, that though Locke has in one passage of his immortal work expressed himself on the subject in terms unintelligible, his sentiments on the whole differed little from those of Berkeley and Hume, adds—"Some of the greatest admirers of that eminent philosopher seem to have overlooked entirely the preceding account of his sentiments on this subject; and, through I know not what passion for the paradoxical (I should rather say the impossible and unintelligible), have shown an amazing zeal for defending the propriety of the hasty expressions which appear in the passages formerly referred to. Has not the mind of man (say they) an unlimited power in moulding and combining its ideas? The mind, it must be owned, hath an unlimited power in moulding and combining its ideas. It often produces wonderful forms of its own out of the materials originally supplied by sense; forms indeed of which there is no exemplar to be found in nature:—centaurs and griffins,

Gorgons and hydras, and chimeras dire.

But still it must not attempt absolute impossibilities, by giving to its creature contradictory qualities. It must not attempt to conceive the same thing to be black and white at the same time; to be no more than three inches long, and yet not less than three thousand; to conceive two or more lines to be both equal and unequal; the same angle to be at once acute, obtuse, and right; or, we may add, the two sides of a triangle to be not greater than the third. See *Philosophy of Rhetoric*, vol. ii. p. 108, &c.

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which is common, making thereof a most abstract idea of extension, which is neither line, surface, nor solid, nor has any figure or magnitude, but is an idea entirely pre-scinded from all these. So likewise the mind, by leaving out of the particular colours perceived by sense that which distinguishes them one from another, and retaining that only which is common to all, makes an idea of colour in abstract, which is neither red, nor blue, nor white, nor any other determinate colour. And as the mind frames to itself abstract ideas of qualities or modes, so does it by the same precision or mental separation attain abstract ideas of the more compounded beings, which include several co-existent qualities. For example: The mind having observed that *Peter*, *James*, and *John*, resemble each other in certain common agreements of shape and other qualities, leaves out of the complex or compounded idea it has of *Peter*, *James*, and any other particular man, that which is peculiar to each, retaining only what is common to all, and so makes an abstract idea wherein all the particulars equally partake, abstracting entirely from and cutting off all those circumstances and differences which might determine it to any particular existence. After this manner, it is said, we come by the abstract idea of *man*, or, if you please, humanity or human nature: in which, it is true, there is included colour, because there is no man but has some colour; but then it can be neither *black* nor *white*, nor any particular colour, because there is no one particular colour wherein all men partake. So likewise there is included stature; but then it is neither tall stature, nor low stature, nor middle stature, but something abstracted from all these; and so of the rest. Moreover, there being a great variety of other creatures that partake in some parts, but not all, of the complex idea of *man*; the mind, leaving out those parts which are peculiar to man, and retaining those only which are common to all the living creatures, frameth the idea of *animal*; which abstracts not only from all particular men, but also from all birds, beasts, fishes, and insects. The constituent parts of the abstract idea of animal, are body, life, sense, and spontaneous motion. By *body*, is meant body without any particular shape or figure, there being no one shape or figure common to all animals, without covering either of hair or feathers or scales, &c. and yet not naked; hair, feathers, scales, and nakedness, being the distinguishing properties of particular animals, and for that reason left out of the abstract idea. Upon the same account, the spontaneous motion must be neither walking, nor flying, nor creeping: it is nevertheless motion; but what that motion is, it is not easy to conceive.

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“Whether others have this wonderful faculty of abstracting their ideas (continues the Bishop), they best can tell; for myself, I find indeed that I have a faculty of imagining or representing to myself the ideas of those particular things which I have perceived, and of variously compounding and dividing them. I can imagine a man with two heads, or the upper parts of a man joined to the body of a horse. I can consider the hand, the eye, the nose, each by itself abstracted or separated from the rest of the body. But then, whatever hand or eye I imagine, it must have some

particular shape, and some particular colour.—Likewise the idea of man that I frame to myself, must be either of a white, or a black, or a tawney, a straight or a crooked, a tall or a low, or a middle-sized man. I cannot by any effort of thought conceive the abstract idea above described. To be plain, I own myself able to abstract in one sense, as when I consider some particular parts or qualities separated from others with which, though they are united in some objects, yet it is possible they may really exist without them. But I deny that I can abstract one from another, or conceive separately those qualities which it is impossible should exist so separated; or that I can frame a general notion by abstracting from particulars in the manner aforesaid; and there are grounds to think most men will acknowledge themselves to be in my case.”

To think this, there are indeed such good grounds, shown to be absurd, that it is probable some of our readers, little conversant with the writings of modern metaphysicians, are by this time disposed to suspect, that the Bishop in his zeal may have misrepresented the doctrine of *abstraction*; as no man in his senses, who is not perverted by some darling hypothesis, can suppose himself capable of tagging together such monstrous inconsistencies, as magnitude which is neither large nor small, and colour which is neither white, red, green, nor black, &c. But that the ingenious prelate, in his account of this process of *lopping* and *pruning*, as Mr Harris contemptuously, but most properly, terms it, has not exaggerated in the smallest degree, is apparent from the following account of *abstraction* given by Mr Locke. “Abstract ideas (says that writer) are not so obvious or easy to children, or the yet unexercised mind, as particular ones. If they seem so to grown men, it is only because by constant and familiar use they are made so: for when we nicely reflect upon them, we shall find that general ideas are fictions and contrivances of the mind that carry difficulty with them, and do not so easily offer themselves as we are apt to imagine. For example, Does it not require some pains and skill to form the general idea of a triangle (which is yet none of the most abstract, comprehensive, and difficult)? for it must be neither oblique nor rectangle, neither equilateral, equicrural, nor scalenon, but *all and none of these at once*. In effect, it is some thing imperfect that cannot exist, an idea wherein some parts of several different and inconsistent ideas are put together.” “Surely (to use the words of principal Campbell*) the bare mention of this hypothesis is equivalent to a confutation of it, since it really confutes itself.” But if any man has the faculty of framing in his mind such an idea of a triangle as is here described, it would be vain in us to dispute with him; for we are possessed of no such faculty, and therefore would fight on unequal terms. All we have to desire is, that the reader would fully and certainly inform himself whether he has such an idea or not; and this can be no hard task to perform. What is more easy for any one than to look a little into his own thoughts, and there try whether he has, or can attain to have, an idea of colour separated from all extension; of extension, which is neither great nor small; of taste, which is neither sweet nor bitter, nor acid,

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acid, nor agreeable, nor disagreeable; or the general idea of a triangle, which is neither oblique nor rectangle, equicrural, equilateral, nor scalenon, but all and none of these at once (L) ?

Dr Reid having denied that there are or can be in the mind any *ideas* of sensible objects, rejects of course the doctrine of *abstract general ideas*, whilst he maintains in fact the same thing, only substituting the word *conception* for the word *idea*. "What hinders me (says he) from attending to the whiteness of the paper before me, without applying that colour to any other object?" We know nothing indeed which can hinder any man from performing this operation, which is daily and hourly performed by infants; but will the Doctor say, that he can attend to colour, or conceive it, abstracted from the paper and every other surface? We are persuaded he will not, though he immediately adds, "the whiteness of this individual object is an *abstract conception*." Now we should rather have thought, that, consistent with his own notions of colour, he would have called the whiteness of the paper a *concrete quality*, and his own conception of it a *particular and concrete conception*. If he conceives the whiteness as separated from the paper, it is no longer the whiteness of that individual object: and he must either conceive it as abstracted from *all* objects, which is plainly impossible: or he must conceive it as inhering in some other object; and then neither the quality of whiteness, nor his conception of it, is abstract and general, but concrete and particular. He affirms, however, "that in abstraction, strictly so called, he can perceive nothing that is difficult either to be understood or practised." This is going much farther into the doctrine than Mr Locke went; for he owned that there was much difficulty in it. Let us see how it becomes so easy to Dr Reid. "What can be more easy (says he) than to distinguish the different attributes which we know to belong to a subject? In a man, for instance, to distinguish his size, his complexion, his age, his fortune, his birth, his profession, and twenty other things that belong to him." All this indeed, and much more, we can do with the utmost ease; but this is not abstraction, strictly so called, nor any thing like abstraction. We distinguish the size, the complexion, the age, &c. of the man, from *one another*: but still we conceive them all as *his* qualities; nor is it possible, at least for us, to *abstract them from him*, without conceiving them as the qualities of some other man; so that *our* conceptions are all concrete and particular. "It ought likewise to be observed (says the Professor), that attributes may with

perfect ease be distinguished and *disjoined* in our conception, which cannot be *actually separated* in the subject." They may be so in his conception, but certainly not in ours; for *we* can conceive nothing which may not actually exist. "Thus (continues he) I can in a body distinguish its solidity from its extension, and its weight from both. In extension, I can distinguish length, breadth, and thickness; yet none of these can be separated from the body, or from one another. It is therefore *certain*, that attributes, which in their nature are absolutely inseparable from their subject and from one another, may be disjoined in our conception; one *cannot exist* without the other, but one *can be conceived* without the other." So far is this from being a matter of *certainly*, that in every possible sense in which we can understand the word *conception*, it appears to us as evidently *false*, as that *three and two are equal to nine*. It is indeed not difficult to distinguish in a body its solidity from its extension, and its weight from both: but can we distinguish them *out of the body*? or, to speak in plain language, can we conceive *solidity* as separated from *all extension and all weight*? Unless this can be done, and by *us* it cannot be done, there is no *abstraction strictly so called*. It is indeed easy to conceive *solidity* or *extension* abstracted from *any one* individual object: but how is it done? Why, by transferring your attention to some other *individual object*. Thus, we can easily conceive *solidity* or *extension* separated from a guinea, for instance; but it is only by transferring our thoughts to another body, *a piece of silver, or a ball of lead, &c.* and our conceptions in both cases are *particular and concrete*.

As we think this opinion of Dr Reid's respecting ABSTRACTION both ill-founded and of dangerous consequences, we have expressed our dissent from it in strong terms; and in doing so we have only followed the example set us by himself when dissenting from the theories of Hume and Berkeley. But we are so thoroughly convinced that the Doctor's acuteness is superior to our own (L), that we are not without our fears that we may have mistaken his meaning. We are conscious that we have not wilfully misrepresented it; and to enable our readers to judge for themselves between him and us, we shall lay before them his definition of *general conceptions* in his own words.

That there are in every language *general terms*, is known to all mankind: for such are all substantives, proper names excepted; and all adjectives. But "it is impossible (says the Doctor*) that words can have a general signification, unless there be conceptions in the

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Terms, how they are
* *Essay on the Intellectual Powers of Man.*

(L) "If such an extraordinary faculty (abstraction) were possible, I cannot for my part conceive what purpose it could serve. An idea hath been defined by some logicians, the form or resemblance of a thing in the mind; and the whole of its power and use in thinking is supposed to arise from an exact conformity to its archetype. What then is the use or power of that idea, to which there neither is nor can be any archetype in nature, which is merely a creature of the brain, a monster that bears not the likeness of any thing in the universe!" — *Philosophy of Rhetoric*, vol. ii. p. 110.

(L) Notwithstanding this declaration, which is made with the greatest sincerity, we do not apprehend that we are guilty of presumption when we examine the Doctor's opinions. Berkeley and Hume were certainly as acute as any metaphysician who has succeeded them; yet their opinions have been canvassed without ceremony, and to much advantage. *Aliquando bonus dormitat Homerus.*

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the mind of the speaker and of the hearer, of *things* (M) that are *general*. It is to such that I give the name of *general conceptions*: and it ought to be observed, that they take this denomination, not from the act of the mind in conceiving, which is an individual act; but from the object or thing conceived, which is general." Now, whatever is conceived, must be either *external* to the mind, or *present* with it. But the Doctor himself acknowledges, "That all the objects we perceive are individuals. Every object of sense, of memory, or of *consciousness*, is an individual object. All the good things we enjoy or desire, and all the evils we feel or fear, must come from individuals; and I think we may venture to say, that every creature which God has made in the heavens above, or in the earth beneath, or in the waters under the earth, is an individual." If this be so, and no man can call it in question, it is obvious that we can have no *general* conception of any thing *external*. The *act* of conceiving is an *individual act*; and therefore the only thing which can be *general*, must be something present with the mind, and different from the *mere act of conceiving*: But what can this be, if not what Berkeley and others call an *idea*? and how can we have an *idea* of which we are not *conscious*? yet every thing of which we are conscious Dr Reid himself acknowledges to be an *individual*.

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of general signification.

But if the doctrine generally received respecting abstract ideas be so very absurd as it has appeared in our representation, how comes it to be so prevalent among the acutest philosophers? To this we answer, that those philosophers have certainly in this instance been imposed upon by the structure of language: Every adjective and every substantive, proper names excepted, are words of general signification; and all science is conversant about general truth: but as words are said to be significant, not of things, but of ideas; and as truth results from the agreement or coincidence of ideas: it has been hastily supposed, that without general ideas there could have been neither general terms nor general truth. This is plausible, but it is not solid. Every object which affects our senses is an individual object; but we perceive that two or more objects which affect some of our senses very differently, affect others of them in precisely the same way. Thus, the paper upon which one writes, the snow which he perceives from his window, and the milk which he may use at breakfast, affect his senses of touch and taste very differently, but they present the same appearance to his eye. This diversity in the one case he believes to proceed from different powers or qualities in the several objects; and the sameness of appearance in the other, from similar qualities in these objects. To the similar qualities, though he can frame no idea of them abstracted from every individual object, he gives one common name; and calls every object which presents the same appearance to his eye that snow does, a *white* object; where the word *white* does not stand for an abstract idea, but for a quality inherent in one or more objects. Hence the origin of adjectives in language, which denote more than can be expressed by any class of substantives; for every adjective, besides the

power of a name, includes in itself the force of a conjunction. See GRAMMAR.

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The other class of general terms comprehends substantives: of which the origin is as follows. The objects about which we have occasion to speak or write are so numerous and so fluctuating, that if every individual had a proper name, a complete language could never be formed. But as there are not perhaps in nature two objects that appear to us similar in all respects, so are there not in nature two objects which affect *all* our senses differently. The mind, therefore, either actually perceiving two or more objects at once, or contemplating the *ideas* left by two or more objects in the memory, perceives, by its intellective power, in what respects they agree and in what they disagree. If the agreement be striking, and in more qualities than one, it combines the several individuals into one class or species, giving to the whole a common name, which equally denotes the species and every individual belonging to it. Thus, observing that Peter, James, and John, agree in having the same erect form, in walking on two legs, in having hands, &c. and in being endowed with reason, we combine these three, and all other individuals which we perceive to agree in the same striking and important qualities, into one species, to which we give the name of *man*—a word which equally denotes the whole species and every individual of it. Again, contemplating several figures, which all agree in the circumstance of being bounded by three straight lines meeting one another so as to form three angles, we call the whole class of figures and each individual by the name of *triangle*—though it may be impossible to contemplate any number of triangles without perceiving that all the angles of one are acute; that one angle of another is a right angle; and that in the third there is one angle obtuse: but the word *triangle*, unless it is limited in its signification by the addition of an adjective, is equally expressive of an acute-angled triangle, a right-angled triangle, and an obtuse-angled triangle. By thus arranging individuals according to their most conspicuous qualities, we may combine all the objects existing into so many classes or species, which shall be afterwards known by as many names; but of each species we neither have, nor can have, any other idea than that of a multitude of similar individuals.

As our acquaintance with nature enlarges, we discover resemblances striking and important between one species and another, which naturally begets the notion of a higher class called a *genus*. From comparing man with beasts, birds, fishes, and reptiles, we perceive that they are all alike possessed of life, or a principle of sensation and action, and of an organised body: hence we rank them all under a higher class or genus, to which we give the name of *animal*; which equally denotes the whole *genus*, each *species* comprehended under the *genus*, and every *individual* of every *species*. Thus, *animal* is a *genus*; *man*, *beast*, *bird*, are so many *species* comprehended under that *genus*; and *Peter*, *James*, and *John*, are *individuals* of the species *man*. *Peter*, *James*, and *John*, are proper names, denoting each an *individual*;

(M) He tells us soon afterwards, that there are *no things general*. How is the one passage to be reconciled with the other?

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dual; *man*, *beast*, *bird*, are *specific* terms, denoting each a *whole species* comprising many *individuals*; and *animal* is a *general term*, because it denotes a *whole genus*, comprehending under it *several species*, of which each consists of many *individuals*; and the general term denotes either the whole *genus*, all the *species*, or any *individual* of all the *species*. This is the whole mystery of *abstraction*: they are merely *terms*, that in strictness of speech are *general* and *abstract*; and even these are general only as *signs*, of which the full signification cannot always be represented by any conceivable *idea*.

"It is a received opinion (says Bishop Berkeley), that language has no other end but the communicating of our ideas, and that every significant name stands for an idea. This being so; and it being withal certain, that names, which yet are not thought altogether insignificant, do not always mark out particular conceivable ideas; it is straightway concluded that they stand for abstract notions. That there are many names in use amongst speculative men, which do not always suggest to others determinate particular ideas, is what nobody will deny: and a little attention will discover, that it is not necessary, even in the strictest reasonings, that significant names, which stand for ideas, should every time they are used excite in the understanding the ideas they are made to stand for. In reading and discoursing, names are for the most part used as letters in algebra; in which, though a particular quantity be marked by each letter, yet to proceed right, it is not requisite that in every step each letter suggest to our thoughts that particular quantity it was appointed to stand for." The same thing is true of ideas, which as well as names are often used merely as signs representing a whole class; and on that account they may be called *general*, though every idea is in itself strictly particular. Thus, "An idea, which considered in itself is particular, becomes general by being made to represent or stand for all other particular ideas of the same sort. To make this plain by an example, suppose a geometrician is demonstrating the method of cutting a line in two equal parts: He draws, for instance, a black line of an inch in length: this, which in itself is a particular line, is nevertheless, with regard to its signification, general; since, as it is there used, it represents all particular lines whatsoever: so that what is demonstrated of it is demonstrated of all lines, or, in other words, of a line in general. And as that particular line becomes general by being made a sign; so the *name* line, and the *idea* of a line in the imagination, either of which taken absolutely is particular, by being signs are made general likewise. And as the former owes its generality, not to its being the sign of an abstract or general line, but of all particular right lines that may possibly exist; so the latter, the name and the idea, must be thought to derive their generality from the same cause, namely, the various particular lines which each of them indifferently denotes." Again, when one demonstrates any proposition concerning triangles, it is to be supposed that he has in view to demonstrate an universal truth; yet the particular triangle which he considers must be either equilateral, isosceles, or scalenon; for a plain triangle, which is none of these, can neither exist nor be conceived. But whether it be of this or that sort is of no importance, as any of them may equally stand for and represent all

rectilineal triangles, and on that account be denominated *universal*.

This doctrine respecting names and ideas being used merely as *signs*, has been adopted by almost every subsequent philosopher; and by Principal Campbell it has been illustrated with perspicuity and acuteness every way worthy of the author of the Dissertation on Miracles. "In confirmation of this doctrine (says he *), it may be observed, that we really think by *signs*, as well as speak by them. All the truths which constitute science, which give exercise to reason, and are discovered by philosophy, are general; all our ideas, in the strictest sense of the word, are particular. All the particular truths about which we are conversant are properly historical, and compose the furniture of memory. Nor do I include under the term *historical* the truths which belong to natural history; for even these too are general. Now, beyond particular truth or historical facts, first perceived and then remembered, we should never be able to proceed one single step in thinking any more than in conversing, without the use of signs.

"When it is affirmed that *the whole is equal to all its parts*, there cannot be an affirmation which is more perfectly intelligible, or which commands a fuller assent. If, in order to comprehend this, I recur to ideas, all that I can do is to form a notion of some individual whole, divided into a certain number of parts of which it is constituted; suppose of the year, divided into the four seasons. Now all that I can be said to discern here is the relation of equality between this particular whole and its component parts. If I recur to another example, I only perceive another particular truth. The same holds of a third and of a fourth. But so far am I, after the perception of ten thousand particular similar instances, from the discovery of the universal truth, that if the mind had not the power of considering things as signs, or particular ideas as representing an infinity of others, resembling in one circumstance though totally dissimilar in every other, I could not so much as conceive the meaning of an universal truth. Hence it is that *some ideas*, to adopt the expression of Berkeley, are *particular in their nature*, but *general in their representation*."

But if in universal propositions, ideas particular in themselves be used only as the signs of others, it may be demanded, how we can know any proposition to be true of all the ideas which are represented by the sign? For example, having demonstrated that the three angles of an isosceles rectangular triangle are equal to two right ones, how can we conclude that this affection therefore agrees to all other triangles which have neither a right angle nor two equal sides? To this question Bishop Berkeley and Principal Campbell give the following answer: Though the idea we have in view whilst we make the demonstration be that of an isosceles rectangular triangle, whose sides are of a determinate length, we may yet be certain that the demonstration extends to all other rectilineal triangles of what sort or bigness soever; for this plain reason, that neither the equality nor determinate length of the sides, nor the right angle, are at all concerned in the demonstration. It is true, the idea or diagram we have in view includes all these particulars; but then there is not the least mention made of them in the proof

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Which, though particular in themselves, serve to demonstrate general truths; because

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proof of the proposition. It is not said the three angles are equal to two right angles, *because* one of them is a *right angle*, or because the sides comprehending it are of equal length; which sufficiently shows that the right angle might have been oblique and the sides unequal; and for all that the demonstration have held good. In every one of Euclid's theorems, a particular triangle, and a particular parallelogram, and a particular circle, are employed as signs to denote all triangles, all parallelograms, and all circles. When a geometrician makes a diagram with chalk upon a board, and from it demonstrates the property of a straight-lined figure, no spectator ever imagines that he is demonstrating a property of nothing else but that individual white figure, five inches long, which is before him.—Every one is satisfied that he is demonstrating a property of all of that order, whether more or less extensive, of which it is both an example and a sign; all the order being understood to agree with it in certain characters, however different in other respects. Nay, what is more, the mind with the utmost facility extends or contracts the representative power of the sign as the particular occasion requires. Thus the same equilateral triangle will with equal propriety serve for the demonstration, not only of a property of all equilateral triangles, but of a property of all isosceles triangles, or even of a property of all triangles whatever. Nay, so perfectly is this matter understood, that if the demonstrator in any part should recur to some property belonging to the particular figure he hath constructed, but not essential to the kind mentioned in the proposition, and which the particular figure is solely intended to represent, every intelligent observer would instantly detect the fallacy: So entirely for all the purposes of science doth a particular serve for a whole species or genus. Now, why one *visible* individual should in our reasonings serve without the smallest inconvenience as a sign for an infinite number, and yet one *conceivable* individual, or a particular idea of imagination, should not be adapted to answer the same end, it will, we imagine, be utterly impossible to say (N).

It must, however, be confessed, that there is a considerable difference in kind, between *ideas* used as signs and the *general* terms of any language. Amongst all the individuals of a species, or even of the highest genus, there is still a natural connection, as they agree in the specific or generic character; and when the mind makes use of any positive idea as the sign of the species or genus, that idea appears in the imagination as an exact resemblance of some one individual. But
N^o 213.

the connection which subsists between words and things, or even between words and ideas, is in its origin arbitrary; and yet its effect upon the mind is much the same with that of the natural connection between ideas and things. For having often had occasion to observe particular words used as signs of particular things, and specific terms used as signs of a whole species, we contract a habit of associating the sign with the thing signified, insomuch that either being presented to the mind necessarily introduces or occasions the apprehension of the other. Custom in this instance operates precisely in the same manner as natural resemblance in the other; so that certain sounds, and the ideas of things to which they are not naturally related, come to be as thoroughly linked in our conceptions as the ideas of things and things themselves. Nay, so completely are they linked together, that we often use, through long chains of reasoning, certain sounds or words, without attending at all to the ideas or notions of which they are signs. "I believe (says the author of *A Treatise on Human Nature*), that every one who examines the situation of his mind in reasoning will agree with me, that we do not annex distinct and complete ideas to every term we make use of; and that in talking of *government*, *church*, *negotiation*, *conquest*, we seldom spread out in our minds all the simple ideas of which the compound notions signified by these terms are composed. It is, however, observable, that notwithstanding this imperfection, we may avoid talking nonsense on these subjects, and may perceive any repugnance among the ideas as well as if we had a full comprehension of them." This remark generally holds true; but then it is to be observed, that all the words used as signs, and which yet do not denote any one conceivable determinate *idea*, must be capable of definition. Thus, in matters that are perfectly familiar, in simple narration, or in moral observations on the occurrences of life, a man of common understanding may be deceived by specious falsehood, but is hardly to be gulled by downright nonsense or a repugnance of ideas. Almost all the possible applications of the terms (in other words, all the acquired relations of the signs) have become customary to him. The consequence is, that an unusual application of any of them is instantly detected; this detection breeds doubt, and this doubt occasions an immediate recourse to *definition*; which, proceeding through species and genera, resolves complex terms into others less complex, till it ends at last in simple ideas and relations, which can neither be defined nor misunderstood (O). See *Logic*.

Thus

(N) Were it possible to frame an *abstract general idea* of a triangle, which is neither equilateral, isosceles, nor scalenon, even *that idea* must be used merely as a sign as much as any particular triangle whatever: and the question might still be asked, How we can know any proposition to be true of all the triangles represented by the sign? For example: having demonstrated that the three angles of an ideal triangle, which is neither equilateral, isosceles, nor scalenon, are equal to two right angles, how can we conclude that this affection agrees to triangles which are equilateral, &c.? To this question it is not easy to conceive what answer could be given other than that of Berkeley and Campbell, in the case of using particular and conceivable triangles as signs.

(O) Since this article was written, some excellent observations on the common doctrine concerning abstraction have been given to the public by professor Dugald Stewart of Edinburgh. See *Elements of the Philosophy of the Human Mind*.

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Thus then we see, that though there are no ideas, properly speaking, general and abstract, a man may by *terms* and *particular* ideas, used as *signs*, arrive at the knowledge of general truth. In neither case is it the *matter*, if we may be allowed the expression, but the *power* of the sign, that is regarded by the mind. We find, that even in demonstrative reasonings, signs the most arbitrary, or mere symbols, may be used with as little danger of error as ideas or natural signs. The operations both of the algebraist and arithmetician are strictly of the nature of demonstration. The one employs as *signs* the letters of the alphabet, the other certain numerical characters. In neither of these arts is it necessary to form ideas of the quantities and sums signified; in some instances it is even impossible without resolving the quantity or sum into parts, in a manner analogous to definition; and then the mind comprehends not the whole quantity or number at once, but the several parts of which it is composed, which it connects (P) by the relation of junction or addition. Yet without this resolution, the equations and calculations carried on by means of the letters and figures significant of the whole quantity or the whole sum, are not the less accurate or convincing. And so much for *abstraction*, *generalization*, and the power of *signs*, whether *natural* or *artificial*.

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A continu-
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thought in
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EVERY man whilst awake is conscious of a continued train of thought spontaneously arising in his mind and passing through it; nor could a single now or instant be pitched upon in which some idea is not present in his memory or imagination. No one idea, however, unless detained by a voluntary exertion of the mind, or unless productive of intense pleasure or pain, remains long in the imagination; but each hastens off the stage to make way for another, which takes its turn and is succeeded by a third, &c. We are not to imagine that this train of thought is altogether fortuitous and incoherent. "It is evident (says Mr Hume *), that there is a principle of connection between different thoughts or ideas of the mind; and that, in their appearance to the memory or imagination, they introduce each other with a certain degree of method and regularity. In our more serious thinking or discourse this is so observable, that any particular thought which breaks in upon the regular tract or chain of ideas, is immediately remarked and rejected. Even in our wildest and most wandering reveries, nay, in our very dreams, we shall find, if we reflect, that the imagination ran not altogether at adventures, but that there was still a connection upheld among the different ideas which succeeded each other. Were the loosest and freest conversation to be transcribed, there would immediately be observed something which connected it in all its transitions: Or, where this is wanting, the person who broke the

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thread of discourse might still inform you, that there had secretly revolved in his mind a succession of thoughts, which had gradually led him from the subject of conversation. Among different languages, even where we cannot suspect the least connection or communication, it is found, that words expressive of ideas the most compounded, do yet nearly correspond to each other; a certain proof that the simple ideas comprehended in the compound ones, were bound together by some universal principle, which had an equal influence on all mankind."

That these observations are well founded, every man may be satisfied by looking attentively into his own thoughts; but when the author reduces the principles of this association of ideas to *three*, viz. *resemblance*, *contiguity* in time and place, and *cause* or *effect*, he certainly contracts them within too narrow a compass. That these principles often serve to connect ideas, will not indeed be denied. A picture leads our thoughts to the original: the mention of one apartment in a building introduces an inquiry or discourse concerning the others: and if we think of a wound, we can hardly forbear reflecting on the pain which follows it. But surely ideas sometimes succeed each other without *resemblance*, without *contiguity* in time or in place, and without being connected by the relation of a *cause* to its *effect*. Besides all this, there are other associations than of *ideas*. Ideas are associated with passions and emotions, and passions and emotions are associated together. A particular idea is associated with a proper name, and often with the general name of the species. General conceptions, such as those which Mr Locke calls mixed modes (see *MODE*), are associated with signs both audible and visible, and signs are associated with each other. Surely virtue, as it consists in action and intention, does not resemble the *sound* virtue, is not *contiguous* to it in time or in place, and is neither its *cause* nor its *effect*; nor is it conceivable, that the arbitrary signs of different things should have any natural relation to one another.

But were the enumeration complete, the bare mention of these principles does not account for the phenomena: For, granting the fact, it may still be asked, Why does a picture lead our thoughts to the original; or the mention of one apartment in a building introduce an inquiry concerning the others? To these questions our author has given no answer; nor are we acquainted with any writer who can be said to have attempted it, except Dr Hartley and his ingenious editor. There may be some of our readers whom the names of these men will prejudice against their theory; but, doubtless, the greater part are willing to adopt truth, or to examine an ingenious speculation, from whatever quarter it comes. To such as feel themselves otherwise disposed, we beg leave to say, that if they allow the name of *Priestley* to disgust them at what follows, they will furnish him with a new proof of the truth of the doctrine which they reject.

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(P) No man, we think, will pretend that he can perceive at one view a million of individual men, or that he can imagine or conceive at once a million of ideal men: yet he may divide the million into parts, which in the one case may be easily viewed, and in the other may be easily conceived, in succession. Thus, 100 + 100 + 100, &c.

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operate.

That *ideas* should be associated together, seems to be inevitable from the manner in which the mind acquires them. All our ideas, properly speaking, are of sensible objects, and by far the greater part of them of *visible* objects. But every sensible object conveys at once various sensations and perceptions to the mind, which appear not only united in fact, but inseparable in imagination. Thus, when a man looks at any particular object, a tree for instance, he perceives the *trunk, branches, leaves, size, shape, and colour, &c.* of the whole at *once*: he does not first perceive the *figure* of the trunk, then its *size*, then its *colour*, then the *branches, &c.* all in succession; but a perception of the *whole* is conveyed to the mind by one simultaneous impression (Q.) We have already seen, that the senses, in fact, convey nothing to the mind but their respective sensations; and that the perception of the external object instantly follows the sensation. We have likewise seen, that sensation is occasioned by some impression, concussion, or vibration, given to the nerves and brain, and by them communicated to the mind or percipient being. We have likewise seen, that memory depends as much upon the brain as original sensation, and is always attended or occasioned by similar concussions or vibrations, &c. These are facts proved by universal experience, and which, we believe, no thinking man has ever called in question. It follows, therefore, that every actual sensation must leave some effect in the brain, either an actual print, which seems to be impossible, or a tendency to vibrate or be agitated in the same way as when the original impression was made. This being the case, it is natural to conclude, that when any part of the original perception is revived in the memory, the whole perception should be revived at once, so as that we cannot have an idea of the trunk of a tree without perceiving the ideas of the branches associated with it. This is indeed not merely natural, but the contrary seems to be impossible; for as the original agitation or vibration was occasioned by the whole tree, it is evident, that whatever effect or tendency that agitation or vibration left behind it, must be left by the whole vibration, and therefore be equally related to the whole tree.

But no object stands single in nature. When we view a tree, or any thing else, we always notice, however transiently, the field where it grows and the objects around it. These too leave effects in the brain at the same time that the tree does so; and therefore make their appearance with it in the memory or ima-

gination: but if the tree was the object to which we principally attended during the actual sensation, the idea of it will be much more vivid than the idea of its adjuncts, and remain much longer in the imagination or memory; because the original sensation by which it was perceived, was struck much deeper than the sensations by which its adjuncts were perceived. All this must be intelligible to every one who attends to what we have already said of sensation, perception, and memory.

Thus we see why a picture leads our thoughts to the original, and why the mention of one apartment in a building introduces an inquiry concerning the others. It is not merely because the picture *resembles* the original, and because the apartments of a building are *contiguous*. Between a plain surface, variously coloured and shaded, and the contour of the human face, there is certainly very little real resemblance, as any man may be convinced who places his eye within six inches of a good picture. But the painter, having by his skill in perspective, contrived to lay his colours on the plain canvas in such a manner as that they reflect the same rays of light with the original, provided the spectator stand at the proper distance; these rays proceeding from the picture fall upon the eye in the same direction, and therefore give to the nerves and brain the very same impulse which was given by the original. When one apartment of a building is mentioned, we inquire concerning the others from the very same cause that, when we think of the trunk of a tree which we have seen, we cannot avoid thinking likewise of its branches.

But the principle of association takes place among things not naturally connected, as the apartments of a building and a substance and its attributes and adjuncts. It is association which is the original source of all the general or complex conceptions which we have, and which even gives meaning to the words of every language. Between sounds considered in themselves, and things, or the ideas of things, every one knows that there is no natural connection; yet the idea of every known object is in the mind of every man so strictly associated with the name that it bears in his native tongue, that the presence of the one always suggests the other. It cannot indeed be otherwise, if we attend to the manner in which a child learns to affix a meaning to the words which he hears.—A child knows his mother and nurse, and indeed almost every visible object in the family, long before he acquires the power of articulation. The impressions made

(Q) This is certainly the case with adults, but it may be doubted whether it be so with very young children. It has been shown already, that the sensation communicated by the eye from any visible object, has not the least resemblance to that object; and that in looking at a tree or any thing else, a full grown man pays not the least attention to the appearance which the tree really makes to his eye; nay, that he is not even conscious of that appearance, farther than as it consists in colour. It is by the sense of touch only that we acquire ideas of figure, even of plain figure; and we imagine that we perceive them by the eye only, because different figures, as distinguishable by touch, are so closely associated with their corresponding visible sensations, that long before we are capable of inquiry, these two things are inseparable in the imagination. It is otherwise with children, who, when they first begin to distinguish objects by the sense of sight, appear to do it with great deliberation, as if they first felt the proper sensation of light and colours so or so modified, and afterwards acquired, by something like a mental inference, a notion of the figure at which they are looking.

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made by these objects, and repeated daily and hourly on his brain, every one of which excites a sensation, must soon become so deep as not to be easily effaced. Numbers of them too are associated together, so that the presence of one introduces the other. It has been already observed, that ideas of sight are the most vivid and the most lasting; but the child having the same sound often repeated, even that sound comes in time to leave in his memory a permanent idea. He then hears the sound *nurse*, for instance, uttered at the time when he is looking earnestly at the person of the nurse, with whom he is well acquainted, and to whom he is strongly attached; and having the two ideas repeatedly excited together, they soon become so associated, that the one necessarily excites the other: the word *nurse* calls into view the idea of the woman treasured up in his imagination.

But we need not have recourse to children for the proof of our assertion. It is obvious that the name of every simple and uncompound idea can be significant only by association. Of a complex conception the name may be made intelligible by a definition; but simple ideas cannot be defined, and between ideas and sounds there is no natural connection, so as that the one previous to association should suggest the other. Even of complex conceptions and mixed modes, the meaning of the names is generally acquired by association; for though it is certainly true, that all such names are capable of definition, they are yet used with sufficient propriety by thousands who know not what a definition is. Were a plain unlettered man asked to define virtue, it is not probable that he could do it so as to make himself understood; yet having ideas of the practice of justice, charity, fortitude, &c. strictly associated in his mind with the word *virtue*, he may know the general meaning of that word as well as the most acute grammarian or the most profound philosopher.

An *alms* is a donation to a poor man; but a child who never heard of this definition knows perfectly what an *alms* is, from having often seen his parents give money to a beggar, and call what they were doing by the name *alms*. The sound of the word, after having seen the first alms given, will excite in his mind an idea of the individual object who received it, and of the action of him by whom it was given; but after having seen several poor men relieved, he comes to associate with the word *alms* any thing given to any person who needs it or appears to be in want.

So completely does this association take place between ideas or clusters of ideas, and the words by which they are expressed, that even men of letters hear and understand perfectly many words without reviewing in their minds all the ideas and relations of which they are the signs. It has been already observed, that in talking of government, church, negotiation, conquest, we seldom spread out in our minds all the simple ideas of which the compound notions signified by these terms are composed; and we now add, that the terms may be used with sufficient propriety, and be perfectly understood by those who never attempted to analyse the notions of which they are significant into their primary and constituent parts. Every man has read numberless details of the transactions of one court with another; he has heard such transactions universally called by the term *negotiation*. The term and the

transactions signified by it are so closely associated in his mind, that they are in a manner inseparable; and by this association he knows the meaning of the term better than he could have done by the most complete definition; which, perhaps, he would find it difficult to give, or even to comprehend.

We have said that the meaning of the word *virtue* is acquired by association, by having often heard that sound applied to certain actions; but it is extremely probable, that the very notion of virtue, simple and uncompound as it appears to be, is acquired in the very same manner. The first rudiments of the notions of right and wrong and obligation seem to be acquired by a child when he finds himself checked and controlled by superior power. At first he feels nothing but mere force, and consequently has no notion of any kind of restraint but that of necessity. He finds he cannot have his will, and therefore he submits. Afterwards he attends to many circumstances which distinguish the commands of a father, or of a master, from those of any other person. Notions of reverence, love, esteem, and dependence, are connected with the idea of him who gives those commands; and by degrees the child experiences the peculiar advantages of filial subjection. He sees also that all his companions, who are noticed and admired by others, obey their parents; and that those who are of a refractory disposition are universally disliked. These and other circumstances now begin to alter and modify the notion of mere necessity, till by degrees he considers the commands of a parent as something that *must not* be resisted or disputed, even though he has a power of doing it; and all these ideas coalescing, form the notions of moral right and moral obligation, which are easily transferred from the commands of a parent to those of a magistrate, of God, and of conscience. This opinion of the gradual formation of the ideas of moral right and wrong, from a great variety of elements associated together, perfectly accounts for that prodigious diversity in the sentiments of mankind respecting the objects of moral obligation; nor do we see that any other hypothesis can account for the facts. If the notion of moral obligation were a simple uncompound idea, arising from the view of certain actions or sentiments; or were it acquired, as it certainly might be, by a chain of reasoning from the nature of God and the nature of man; why should it not in the one case be as invariable as the perception of colours or sounds, and in the other as our judgements of mathematical or physical truths? But though the shape and colour of a flower appear the same to every human eye; though every man of common understanding knows, that if a billiard ball be struck by another, it will move from its place with a velocity proportioned to the force of the impulse; and though all mankind who have but dipped into mathematics, perceive that any two sides of a triangle must be greater than the third side; yet one man practises as a moral duty what another looks upon with abhorrence, and reflects on with remorse. Now a thing that varies with education and instruction, as moral sentiments are known to do, certainly has the appearance of being generated by a series of different impressions and associations in some such manner as we have endeavoured to describe. Let not any man imagine that this account of the origin of moral sentiments endangers the cause of virtue; for whether

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* Locke's
Essay, and
his Conduct
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those sentiments be instinctive or acquired, their operation is the very same, and in either case their rectitude must often be tried by the test of reason, so that the interests of virtue are equally safe on this as on any other scheme. See *MORAL Philosophy*.

This principle of association has so great an influence over all our actions, passions, reasonings, and judgments, that there is not perhaps any one thing which deserves more to be looked after in the education of youth. Some of our ideas—such as those of a substance and its attributes, a genus and the species contained under it, a species and its several individuals, have a real connection with each other in nature. These it is the office of our reason to trace out and to hold together in that union and order in which nature presents them to the view of the mind; for such associations constitute perhaps the greatest part of necessary and of useful truths. But there are others formed by custom and caprice, which are too often the sources of error, superstition, vice, and misery—of errors the more dangerous, and of vice the more deplorable; that if the associations have been long formed without an attempt to dissolve them, they generally become at last too strong to be broken by the most vigorous effort of the best disposed mind. Thus, let a foolish maid* amuse or rather frighten children with stories of ghosts appearing in the dark, let her repeat these fictions till they have made a deep impression on the young minds, and the notion of ghosts will in time become so closely associated with the idea of darkness, that the one shall always introduce the other; and it may not be in the power of the children, after they have become men, and are convinced in their judgments of the falsehood and absurdity of the tales which originally frightened them, to separate entirely the notion of ghosts from the idea of darkness, or with perfect ease to remain alone in a dark room. Again, let the idea of *infallibility* be annexed to any person or society, and let these two inseparably united constantly possess the mind; and then one body in ten thousand places at once shall, unexamined, be swallowed for an incontrovertible fact, whenever that infallible person or society dictates or demands assent without inquiry.

Some such wrong and unnatural combinations of ideas will be found to establish the irreconcilable opposition that we find between different sects in philosophy and religion; for we cannot imagine every individual of any sect to impose wilfully on himself, and knowingly to reject truth offered by plain reason. That which leads men of sincerity and good sense blindfold, will be found, when inquired into, to be some early and wrong association. Ideas independent and of no alliance to one another, are by education, custom, and the constant din of their party, so linked together in their minds, that they can no more be separated from each other than if they were but one idea; and they operate upon the judgment as if they really were but one. This gives sense to jargon, the force of demonstration to absurdities, and consistency to nonsense: it is the foundation of the greatest and most dangerous errors in the world; for as far as it obtains, it hinders men from seeing and examining.

Before we dismiss the subject of association, it may be proper to inquire, how far it is agreeable to the ac-

count which we have given of the manner in which external objects are perceived by means of the senses, and the ideas of such objects retained in the memory. Association of Ideas.

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—It has been proved, we think, by arguments unanswerable, that by the organs of sense nothing is conveyed immediately to the mind but sensations which can have no resemblance to external objects, and that the perception of an object may be resolved into a process of reasoning from effects to causes.—But children, it will be said, do not reason from effects to causes, and yet they soon acquire the faculty of perceiving and distinguishing the objects with which they are surrounded. This is an undoubted truth, and it can be accounted for only by the principle of association. A child has as much the use of his senses as a full grown man. By his eye he has the sensation of colour; by his nose, that of smell; by his ear he has the sensation of sound; and by his hand he feels heat and cold, resistance and bounded resistance. Every object which is presented to him, impresses his mind with various sensations: and these sensations combined together are probably all that he perceives for some years; for there is no reason to imagine that a boy of one or two years old has the slightest notion of what we mean by solidity, hardness, softness, or indeed of that which is termed *substance*. Yet when two or more objects are present, he may easily distinguish the one from the other, because the sensations excited by the one must differ from those excited by the other, as much as the real qualities of the one are different from the real qualities of the other; and by distinguishing between his own sensations, he in effect distinguishes between the objects which produce these sensations. His sensations too being frequently excited, leave behind them ideas in his memory or imagination; and those ideas, from having been imprinted together and never separated, become in time so closely associated, that whenever one of them is called into view, the others necessarily make their appearance with it. Thus a child has a set of combined sensations excited in his mind by the presence of his nurse; he has a different cluster excited, suppose, by the presence of his mother. These are often repeated, and leave deep traces behind them; so that when the mother or the nurse makes her appearance, she is immediately recognised as a known object; or, to speak more correctly, the child feels the very same sensations which he has felt before, from which he has experienced pleasure, and of which he has the ideas treasured up in his memory or imagination. A stranger, on the other hand, must affect him with a set of new sensations, and of course will be distinguished from a known object as accurately as if the child were possessed of the notions of solidity, substance, qualities, and distance. A man born blind, who knew not that such things as fire and snow had ever existed, would yet distinguish the one from the other the moment that he should be brought within their influence. He could not indeed apply their names properly, nor say which is the fire and which the snow, nor would he at first have any notion of either of them as a real, external, and distant object; but he would certainly distinguish his own sensations, the sensation of heat from that of cold. It is just so with a child: At first he perceives nothing but different sensations. These he

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can distinguish; and as they are caused by different objects, in distinguishing between the sensations he will appear to distinguish between the objects themselves. In a short time, however, he acquires, by the following process, some inaccurate notions of distance. He looks, for instance, earnestly in his nurse's face, and at the same time touches her cheek perhaps by accident. He repeats this operation frequently, till the sensation communicated by his eye comes to be associated with that of his touch, and with the extending of his arm; and being all treasured up as associated ideas in the memory, the sight of his nurse makes him ever afterwards stretch out his hands with a desire to touch her. All this while there is not the slightest probability that the child has any notion of *substance* or *qualities*, or of any thing beyond his own *sensations*, and the means by which he has experienced, that sensations which are pleasant may be obtained, and that such as are painful may be avoided. The precise time at which a child begins to think of external things we cannot pretend to ascertain; but we are persuaded that it is later than many persons imagine, and certainly not till he has made considerable progress in the exercise of reason. Prior to that period the things which men know to be bodies, are known to children only as sensations and ideas strongly bound together by the tie of association.

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But if association be of such importance in the act of sensation, it is of still greater in that of retention; for it seems to constitute the whole difference that there is between imagination and memory. By many of the ancients, as well as by some modern philosophers, these two faculties seem to have been confounded with each other; but between them there is certainly a great difference, though they likewise resemble each other in some respects. An idea of memory, considered by itself, makes the very same appearance to the intellect as an idea of imagination. We contemplate both as if they were actual, though faint and distant perceptions: but the one is attended with the conviction, that it is the idea of an object which has really been perceived at some period of past time; whilst the other is attended with no conviction, except that the idea itself is actually present to the mind. Mr Hume has said, that ideas of memory differ from those of imagination only in being more vivid and distinct; but certainly this is not always the case. An idea of imagination has sometimes been taken for a real perception, which an idea of memory can never be. The difference between these two kinds of ideas, we are persuaded, arises chiefly, if not wholly, from association. Every idea of memory is associated with many others, and those again with others down to the very moment of the energy of remembrance; whereas ideas of imagination are either the voluntary creatures of the fancy at the moment of their appearance, in which case we should call them conceptions; or they are ideas which we have actually received from sensation, but which, on account of some link being broken in the vast chain of association, we cannot refer to any real objects. What gives probability to this conjecture is, that ideas often appear in the mind which we know not whether to refer to the memory or imagination, nothing being more common than to hear a person say, I have in my head the idea of such

or such an object; but whether I remember or only imagine the object, I am very uncertain. Afterwards, however, by turning the idea over and over in the mind, he finds other ideas make their appearance, till at last clusters of them come into view, and associate so closely with the principal idea, which was the object of doubt, as to convince the judgment that it is an idea of memory.

It has been asked, Why we believe what we distinctly remember? and to that question it has been supposed that no answer can be given. But it appears to us, that association is the ground of belief in this as it will be found to be in other instances; and that a man believes he washed his hands and face in the morning, because the idea of that operation is so strongly linked in his mind to the whole train of ideas which have arisen in it through the day, that he cannot separate the first from the last, that which was a sensation in the morning from the sensations which are present at the instant of remembrance. As those ideas are associated by nature, each must pass in review in its proper order; so that in so short a space of time there is no danger, and hardly a possibility, of taking the first for the last, or the last for the first. Nay more, we will venture to hazard an opinion, that every past event of a man's life, which he distinctly remembers, is tied by the chain of association to his present perceptions. That this is possible is certain, since it is not difficult to conceive how it may be done. The principal events of a single day may surely be so linked together as to be all distinctly reviewed in a cluster of ideas on the morrow. Of these events some one or other must be the most important, which will therefore make its appearance as an idea more frequently than the rest, and be more closely associated with the events of next day. Some event of that day will, for the same reason, be more closely associated with it than the others; and these two, dropping perhaps all the rest of their original companions, will pass on together to the third day, and so on through weeks and months and years. In the compass of a year, several things must occur to make deep impressions on the mind. These will at first be associated together by events of little importance, like the occurrences of a single day. Whilst these feeble chains, however, continue unbroken, they will be sufficient to link the one important event to the other, and to bring them both into view at the same time, till at last these two, from appearing so often together, will in time unite of themselves, and the intermediate ideas be completely effaced. Thus may two or three important events of one year be associated with such a number of similar events of another year, so that the ideas of the one shall always introduce to the mind the ideas of the other; and this chain of association may pass from the earliest event which we distinctly remember through all the intermediate years of our lives down to the instant when memory is exerted.

To this account of memory it may perhaps be objected, that it gives us no distinct notion of time. Every thing that is remembered is necessarily believed to have been present in some portion of past time; but association brings into view nothing but a series of events. This objection will be seen to have no weight when we have inquired into the nature of time, and ascertained what kind of a thing it is. It will then

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then perhaps appear, that duration itself, as apprehended by us, is not distinguishable from a series of events; and that if there were no train of thought passing through our minds, nor any motion among the objects around us, time could have no existence. Meanwhile, whatever become of this opinion, we beg leave to observe, that our theory of remembrance is perfectly consistent with the commonly received notions respecting time; and indeed, that it is the only theory which can account for numberless phenomena respecting past duration. It is universally allowed, that if motion or a succession of events do not constitute time, it is the only thing by which time can be measured. Now it is a fact which no man will deny, that the distance of time from the present *now* or instant to the earliest period which he distinctly remembers, appears to his view extremely short, much shorter than it is said to be in reality; and that one year, when he looks forward, appears longer than two, perhaps longer than ten, when he looks backward. Upon our principles this fact is easily accounted for. We remember nothing which is not linked by a chain of associations with the perceptions of the present moment; and as none but a few of the most important events of our lives can be linked together in this manner, it hence follows, that events which, in the order of succession, were far *distant* from each other, must thus be brought *together* in the memory, and the whole chain be contracted within very short limits. But when we figure to ourselves a series of future events, we employ the active power of fancy instead of the passive capacity of retention; and can therefore bring within the compass of one periodical revolution of the sun a longer series of imaginary events succeeding each other, than is preserved of real events in our memory from the earliest period of our existence. So perfectly does our theory accord with this well-known fact. On the other hand, if memory be an original faculty of the mind totally independent of association, and of which no other account is to be given than that it necessarily commands our belief, why is it a faculty which, with regard to duration, thus uniformly deceives us? and how comes it to pass, that to a man whose memory is tenacious, who has read much, seen many countries, and been engaged in various occurrences, any determinate portion of past time always appears longer than to another man whose memory is feeble, and whose life has been wasted in ease and idleness? To these questions we know not what answer can be given upon any other principle than that which makes the evidence of memory depend upon association. But if we remember nothing but what is linked to the perception or idea which is present with us at the time of remembrance, and if duration be measured by the succession of events, it is obvious that any portion of past time must necessarily appear longer to him who has many ideas associated in his mind than to him who has but few.

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The importance of association in the philosophy of the human mind.

There is not perhaps a single fact of greater importance in the philosophy of the human mind than the

association of ideas; which, when thoroughly understood, accounts for many of those phenomena which some late writers of name have, with injury to science and with danger to morality, attributed to a number of distinct and independent instincts. It is for this reason that we have considered it so minutely, and dwelt upon it so long; and in addition to what we have said on the subject, we beg leave to recommend to our more philosophical readers the diligent study of Hartley's *Observations on Man* (R). In that work we think several things are taken for granted which require proof; and some which, we are persuaded, have no foundation in nature: but, with all its defects, it has more merit than any other treatise on the sensitive part of human nature with which we are acquainted.

CHAP. VI. Of CONSCIOUSNESS and REFLECTION.

SENSATION, remembrance, simple apprehension, and conception, with every other actual energy or passion of the mind, is accompanied with an inward feeling or perception of that energy or passion; and that feeling or perception is termed *consciousness*. *Consciousness* is the perception of what passes in a man's own mind at the *instant* of its passing there; nor can we see, hear, taste, smell, remember, apprehend, conceive, employ our faculties in any manner, enjoy any pleasure, or suffer any pain, without being *conscious* of what we are doing, enjoying, or suffering. *Consciousness* is only of things *present**; and to apply it to things *past*, is to confound *consciousness* with memory or reflection. One cannot say that he is conscious of what he has seen or heard and now remembers: he is only conscious of the act of remembrance; which, though it respects a past event, is itself a present energy. It is likewise to be observed, that consciousness is only of things in the mind or conscious being, and not of things external. It is improper in any person to say that he is *conscious* of the table before him: he perceives it, he *sees* it; and he may with great propriety say that he is *conscious* he perceives or sees it; but he cannot say that he is conscious of the table itself, for it is only his immediate energy of perception that can be the object of consciousness. All the operations of our minds are attended with consciousness; which is the only evidence that we have or can have of their existence. Should a man take it into his head to think or to say that his consciousness may deceive him, and to require a proof that it cannot, we know of no proof that can be given him: he must be left to himself as a man that denies first principles, without which there can be no reasoning. Every attempt to prove this point, or to set it in a clearer light, would only serve to render it more dark and unintelligible. *I think, I feel, I exist*, are first truths, and the basis of all human knowledge.

This has given rise to the question, whether Des Cartes did not fall into an absurdity when, inferring his own existence from his actual thought, he said, *Cogito, ergo sum*? This argument has been called a pitiful sophism, and a *petitio principii*; because, before a man

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Consciousness, what it is, and what are its objects.

* Reid's *Essays on the Intellectual Powers of Man*.

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Des Cartes's argument from consciousness for his own existence.

(R) Since this was written Mr Stewart's *Elements of the Philosophy of the Human Mind* have been published; in which the reader will find many excellent remarks on the nature and influence of the associating principle.

Of Consci-
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Of Consci-
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* See Buf-
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man take it for granted that he thinks, he must also, it is said, take it for granted that he exists, since there cannot be thought where there is no existence. Now it must be confessed, that if Des Cartes pretended by this argument to give us a fresh conviction of our own existence, his endeavours were useless and puerile; because a man capable of being convinced by the arguments of another, must have a previous conviction of his own existence: but the argument itself is certainly neither a sophism nor a *petitio principii*. Those* who defend Des Cartes assert, and there is no reason to doubt the truth of their assertion, that his only view in urging such an argument was not to prove the truth of our existence, but to exhibit the order of that process by which we arrive at the knowledge of the fact; and this he has very clearly done by analysing the truth into its first principles. A stone exists as well as the human mind; but has the stone any knowledge of its own existence? No man will say that it has; neither should we have any knowledge of ours, did we think as little as the stone. We certainly *might* exist without thinking, as it is probable we do in very sound sleep; and in that state our existence might be known to other beings, but it could not possibly be known to ourselves: for the only things of which the mind is conscious, or has immediate knowledge, are its own operations. I *exist* is therefore a legitimate inference from the proposition I *think*; and the observation that it is so may be useful to show us the procedure of the mind in the acquisition of knowledge; but it has little merit as an argument, and still less as a discovery, though, being strictly true and just, it should never have been exposed to ridicule.

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Reflection,
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and how
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* Reid's E-
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It is to be observed, that we are conscious of many things to which we give very little attention. We can hardly attend to several things at the same time; and our attention is commonly employed about that which is the *object* of our thought, and rarely about the thought itself. It is in our power, however, when we come to the years of understanding, to give attention to our own thoughts and passions, and the various operations of our minds. And when we make these the objects of our attention, either while they are present, or when they are recent and fresh in our memory, we perform an act of the mind which is properly called *reflection*. This *reflection* ought to be distinguished from *consciousness**, with which it is confounded sometimes by Locke, and often by the learned author of Ancient Metaphysics. All men are *conscious* of the operations of their own minds at all times while they are awake, nor does it appear that brutes can be wholly destitute of consciousness; but there are few men who *reflect* upon the operations of their minds, or make them the objects of thought; and it is not probable that any species of brutes do so.

From infancy, till we come to the years of understanding, we are employed solely about sensible objects. And although the mind is conscious of its operations, it does not attend to them; its attention is turned solely to the objects about which these operations are employed. Thus, when a man is angry, he is *conscious* of his passion; but his *attention* is turned to the *person* who offended him and the *circumstances* of the *offence*, while the *passion of anger* is not in the least the object of his attention. The difference between *consciousness*

and *reflection*, is like the difference between a superficial view of an object which presents itself to the eye while we are engaged about something else, and that attentive examination which we give to an object when we are wholly employed in surveying it. It is by consciousness that we immediately acquire all the knowledge which we have of mental operations; but attentive reflection is necessary to make that knowledge accurate and distinct. *Attention* is a voluntary act; it requires some exertion to begin and continue it; and by great exertion it may be continued for a considerable time; but *consciousness* is involuntary, and of no continuance, changing with every thought. The power of reflection upon the operations of their own minds does not at all appear in children. Men must have come to some ripeness of understanding before they are capable of it. Of all the powers of the human mind it seems to be the last that unfolds itself. Most men seem incapable of acquiring it in any considerable degree; and many circumstances conspire to make it to all men an exercise of difficulty. The difficulty, however, must be conquered, or no progress can be made in the science of our own or of other minds.

All the notions which we have of mind and of its operations are got by reflection; and these notions are by Mr Locke called *ideas of reflection*. This term we think extremely ill chosen; and we believe it has been the source of much error and confusion among Locke's followers. A man, by attending to the operations of his own mind, may have as distinct *notions* of remembrance, of judgment, of will, of desire, as of any object whatever: but if the secondary perception of a sensible object, that appearance which it has to the mind when viewed in the memory or imagination, be properly called an *idea*, it is certain that of the operations of the mind itself there can be no ideas; for these operations, when reflected on, make no appearance without their objects either in the memory or in the imagination. Nothing is more evident, in fact, than that we have no *ideas*, in the original and proper meaning of the word, but of sensible objects, upon which the mind exerts its first operations. Of these operations we have indeed a consciousness; but abstracted from their objects we cannot frame of them any idea or resemblance. We are *conscious* to ourselves of *thinking*, *willing*, *remembering*, *discerning*, *reasoning*, *judging*, &c. but let any one look into himself, and try whether he can there find any *idea* of *thinking* or *willing*, &c. entirely separate and abstracted from the *object* of thought or will. Every man who has seen a tree or a house, will find in his mind ideas of these objects, which he can contemplate by themselves, independent of every thing else; but no man can contemplate the *idea* of thinking or desiring without taking into view the thing thought on or desired. It is plain, therefore, that the energies of *thinking*, *willing*, and *desiring*, with all their various modifications, are not themselves *ideas*, or capable of *communicating* ideas to be apprehended, as the ideas of bodies are apprehended by the pure intellect. They are the *actions* and *workings* of the *intellect itself* upon ideas which we receive from the objects of sense, and which are treasured up in the memory or imagination for the very purpose of furnishing the intellect with materials to

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work upon. Between *ideas* and the *energies of thinking* there is as great and as obvious a difference as there is between a *stone* and the *energies* of him by whom it is cast. Ideas are the passive subjects; the energies of thinking are the operations of the agents. Ideas are reliëts of sensation, and have a necessary relation to things external; the energies of thinking are reliëts of nothing, and they are wholly and originally internal.

That we can in no sense of the word be said to have *ideas* of the operations of the intellect, will be still more evident if we consider by what means we acquire the knowledge which we have of those operations. It has been already observed, that when our thoughts are employed upon any subject, though we are conscious of thinking, yet our *attention* is commonly employed upon the *object* of our thought, and not upon the *thought* itself: and that if we would give attention to our thoughts and passions, we must do it by a reflex act of the mind, whilst the act of thinking is still recent and fresh in our memory. Thus, if a man wishes to know what perception is, it is not the time to make the inquiry while he is looking at some rare or beautiful object; for though he is *conscious* of the energy of perceiving, the *object* of perception employs all his *attention*. But the time to make this inquiry is either when the object has become familiar to him, or presently after it is removed from his sight. In the former case, he can look upon it without emotion, pay attention to every step in the process of perception, and be immediately conscious what perception is. In the latter case, by turning his attention inwards, and reflecting on what he did or felt when the object was before him, he will find clear and vivid ideas of every thing which he perceived by his sense of sight; but he will find no *idea* of the act of *seeing* or *perceiving*. On the contrary, if he be capable of sufficient attention, he will observe that his intellect is employed in the very same manner upon the *ideas* that it was upon the original *sensations*; and of that employment, and the manner of it, he will be equally conscious as he was of the original energy exerted in sensation. There is indeed this difference between the two, without which reflection could make no discoveries, that the most vivid ideas being still faint when compared with actual sensations, the intellect is not so wholly engrossed by them as it was by the original objects, nor is it so rapidly carried from idea to idea as it was from sensation to sensation. It is thus at leisure to attend to its own operations, and to know what they are; though to form *ideas* of them as separate from their objects, is absolutely impossible. Every man capable of paying attention to what passes within himself when he sees, hears, and feels, &c. may have very accurate *notions* of *seeing*, *hearing*, and *feeling*, &c. but he cannot have *ideas* of them as he has of the *objects* of *sight*, *hearing*, and *touch*.

The same is the case with respect to the exertion of our reasoning faculties. A man must have distinct and clear *ideas* to reason upon, but he can have no *idea* of reasoning itself, though he must be conscious of it, and by attention may know what it is. When a man sits down to study for the *first time* a proposition in the Elements of Euclid, he certainly employs his reasoning faculty, and is conscious that he is doing so; but his attention is wholly turned to the diagram be-

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fore him, and to the several ideas which the diagram suggests. Afterwards, when he has mastered the proposition, he may go over it again, with a view to discover what reasoning is; but he will not find he has any *idea* of reasoning as he has of the diagram. He will only exert that faculty a second time, and perceive one truth linked to and depending upon another in such a manner that the whole taken together forms a complete demonstration. In a word, the operations of our own minds, when attention is paid to them, are known immediately by consciousness; and it is as impossible that we should have ideas of them, as that a living man should be a picture upon canvas. He who attends to what passes in his own mind when he perceives, remembers, reasons, or wills, must know by consciousness what these operations are, and be capable of forming very accurate notions of them, as connected with their objects; and he who does not attend to what passes in his own mind will never acquire any notions of them, though he were to read all that has been written on the subject from the days of Pythagoras to those of Dr Reid.

As we acquire ideas of external objects by means of our senses; and notions of perceiving, remembering, reasoning, and willing, &c. by reflecting on the operations of our own minds; so are there other things of which we acquire notions, partly by sensation, partly by reflection, and partly by means of that faculty of which it is the more peculiar office to compare ideas and to perceive truth. Such are *substance*, *body*, *mind*, with their several qualities, adjuncts, and relations; the knowledge of which, as has been already observed, constitutes what in strictness of speech is termed the science of *metaphysics*. These shall be considered in order, after we have investigated the nature of truth, and inquired into the several sources of evidence; but there is one notion, about the origin and reality of which there have been so many disputes, which in itself is of so great importance, and which will be so intimately connected with all our subsequent inquiries, that it may not be improper to consider it here.—The notion to which we allude is of POWER.

Among the objects around us we perceive frequent changes, and one event regularly succeeding another. Gold thrown into the fire is changed from a fixed to a fluid body. Water exposed to a certain degree of cold is changed from a fluid to a fixed body. Night succeeds to day, and summer succeeds to winter. We are conscious of new sensations in ourselves every hour. We are likewise conscious of reasoning, willing, and desiring; and we know that by an exertion of will we can rise or sit, stand still or walk, call one idea into view, and dismiss others from our contemplation. Experience teaches us, that it is not occasionally, but always, that gold is changed into a fluid by being thrown into the fire, and water into a fixed body by being exposed to a certain degree of cold; that night succeeds to day, and summer to winter. These changes have regularly taken place since the creation of the world; and it has never once been observed that water was fixed by fire, or gold rendered liquid by cold. Were we not assured by experience that our own voluntary motions are produced by exertions of our minds, of which we are conscious, and that without such

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which we
know partly
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and partly by
reflection,
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Our notion
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such exertions those motions would never have taken place, we should probably have considered the liquification of gold as an event equally independent of fire, though uniformly conjoined with it, as night is independent of day, and day of night. But having experienced that we can move or not move our bodies as we please; that when it is our will to sit, we never get up to walk; and that when we wish to walk, we always do it except prevented by external violence; having likewise experienced, that by a thought, by some internal and inexplicable exertion of our minds, we can call up in our memory or imagination one idea and dismiss others from our mental view; we are led to believe with the fullest conviction, that all those motions of our bodies which in common language are termed *voluntary*, and that succession of ideas which follows a conscious exertion of the mind, depend upon ourselves. In other words, we are necessitated to believe that we have a *power* to move or not move our bodies in many cases, and a *power* to turn our attention to one idea in preference to others.

It is thus that we acquire the notion of *power* in ourselves, which we easily transfer to other objects. Knowing that the various motions of our bodies thus effected proceed from power, we are naturally led to inquire whether the changes which we perceive in other bodies may not proceed from *power* likewise, i. e. from something analogous to that power, of the exertions of which we are conscious in ourselves. Now uniform experience teaching us that gold is liquified by being thrown into the fire, and that water is fixed by being exposed to cold; we infer with the utmost certainty that there are *powers* in fire and cold to produce these changes, and that without the exertion of such *powers* these changes would not be produced. We cannot indeed say of external powers, as we can of our own, in what substance they inhere. We know with the utmost certainty that the voluntary motions of our hands, &c. are produced by a power not inherent in the hands but in the mind, for of the exertion of that power we are conscious; but we do not know whether the power which liquifies gold be inherent in that sensible object which we call *fire*, or in something else to which fire is only an instrument. We learn by observation, that the minute particles of fire or heat insinuate themselves between the particles of gold, and, if we may use the expression, tear them asunder; but whether they do this in consequence of a *power* inherent in themselves, or only as instruments impelled by another *power*, is a question which *observation* cannot enable us to answer.

Were we not conscious of the exertion of our own powers, it seems not conceivable that we could ever have acquired any notion of power at all; for power is not an object of sense, nor, independent of its operations, is it indeed an object of consciousness. In external operations, all that we perceive is *one thing*, in which we suppose the *power* to reside, followed by another, which is either the *change* or that on which the change is *produced*; but the exertion of the power itself we do not perceive. Thus we perceive gold, after it has been some time in the fire, converted from a fixed to a fluid body; but we perceive not by our senses either the power or the energy of the power

which operates to this conversion. In the exercise of our own powers, the case is otherwise. When a man puts his hand to his head, and afterwards thrusts it into his bosom, he not only perceives by his senses the change of position, but is also conscious of the energy or exertion by which the change was produced.

“Suppose (says Mr Hume†) a person, though endowed with the strongest faculties of reason and reflection, to be brought on a sudden into this world; he would indeed immediately observe a continual succession of objects, and one event following another, but he would not be able to discover any thing farther. He would not at first by any reasoning be able to reach the idea of cause and effect; since the particular powers by which all natural operations are performed never appear to the senses. The impulse of one billiard ball is attended with motion in the second. This is the whole that appears to the *outward* senses. The mind feels no sentiment or *inward* impression from this succession of objects; consequently there is not, in any single particular instance of cause and effect, any thing which can suggest the idea of power or necessary connection. From the first appearance of an object, we never can conjecture what effect will result from it: but, were the power or energy of any cause discoverable by the mind, we could foresee the effect even without experience; and might at first pronounce with certainty concerning it by the mere dint of thought and reasoning. It is impossible, therefore, that the idea of power can be derived from the contemplation of bodies in single instances of their operations; because no bodies ever discover any power which can be the original of this idea.”

There is a sense in which this reasoning is unquestionably just. A man who had never been conscious of exerting power in himself, would certainly not acquire the notion of power from observing a continual succession of external objects. The impulse of one billiard ball being followed by the motion of another, would no more lead him to the notion of power in the former, than the succession of night to day would lead him to the notion of a power in light to produce darkness. When Mr Hume says, “that from the *first* appearance of an object *we* can never conjecture what effect will result from it,” he uses language that is ambiguous, and utters an assertion which is either true or false according to the sense in which it is understood. If it be meant, that after having reflected on the operations of our own minds, and learned by experience that motion is communicated by impulse from one ball of ivory to another, we could not conjecture whether a similar effect would be produced by the impulse of balls made of other hard bodies which we had never before seen, the assertion is manifestly false. A man who had but once seen motion communicated in this manner from one *ivory* ball to another, would certainly conjecture that it might be communicated from one *wooden* ball to another; and if he had seen it repeatedly communicated from one ball to another of different substances, he would infer, with the utmost confidence, that it might be communicated from ball to ball of whatever substance composed, provided that substance be hard, or of a similar texture with the balls to the impulse of which he had formerly paid attention.

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attention. If by this ambiguous phrase the author only means, as is probably the case, that from the first appearance of an object to which we had never before observed anything in any respect similar, we could not conjecture what effect would result from it; or if his meaning be, that a man suddenly brought into the world, who had never acquired such a notion of power as may be had from attention to the energies and operations of our own minds, would not, by observing an effect to result from one body, conjecture from the first appearance of another similar body what effect would result from it; in either of these cases his assertion is certainly true, and tends to prove, that without the consciousness of the operations of our own minds we could never acquire a notion of power from the changes perceived by our senses in external objects.

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Mr Hume attempts to prove that we can have no notion whatever of power.

But Mr Hume, not contented with denying, which he might justly do, that we could ever have derived the idea of power merely from observing the continual succession of external objects, labours hard to prove that we have no notion of power at all, and that when we use the word *power*, we do nothing more than utter an insignificant sound. To pave the way for the arguments by which so extravagant a paradox is to be supported, he lays it down as a "proposition which will not admit of much dispute, that all our ideas are nothing but copies of our impressions; or, in other words, that it is impossible for us to think of any thing that we have not antecedently felt either by our external or internal senses." As this proposition, however, will admit, it seems, of some dispute, he takes care, before he applies it to the purpose of demolishing all power, to support it by two arguments. "First (says he), when we analyse our thoughts or ideas, however compounded or sublime, we always find that they resolve themselves into such simple ideas as were copied from a precedent feeling or sentiment. Those who would assert, that this position is not universally true nor without exception, have only one, and that an easy, method of refuting it; by producing that idea, which, in their opinion, is not derived from this source. Secondly, If it happen, from a defect of the organ, that a man is not susceptible of any species of sensation, we always find that he is as little susceptible of the correspondent ideas. A blind man can form no notion of colours, a deaf man of sounds. And tho' there are few or no instances of a like deficiency in the mind, where a person has never felt, or is wholly incapable of a sentiment or passion that belongs to his species; yet we find the same observation to take place in a less degree. A man of mild manners can form no idea of inveterate revenge or cruelty; nor can a selfish heart easily conceive the heights of friendship and generosity."

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His reasoning is sophistical.

As these propositions are the engines by which all power is banished from the world, it may not be improper, before we proceed to inquire by what means they perform so arduous a task, to consider their own

inherent strength; for if they be weak in themselves, their work, however dexterously they may be employed, can have no stability. We have already noticed the perverseness of this writer's language, when it confounds *sensations* with *impressions*; but here it is still more perverse, for passions, sentiments, and even *consciousness*, are styled *impressions*. When sensations are confounded with impressions, the effect is only mistaken for the cause, it being universally known that sensations proceed from impressions made upon the organs of sense. When consciousness is confounded with an impression, one thing is mistaken for another, to which it is universally known to have neither resemblance nor relation. But, not to waste time upon these fallacies, which, though dangerous if admitted, are yet too palpable to impose upon a reader capable of the slightest attention, let us examine the propositions themselves. The most important, and that for the sake of which alone the others are brought forward, is, that it is impossible for us to think of any thing that we have not immediately felt, either by our external or internal senses." Did Mr Hume then never think of a mathematical point, or a mathematical line? Neither of these things is capable of being felt either by making an impression upon the organs of sense or as an object of consciousness; and therefore it is impossible that he should ever have had ideas of them such as he doubtless had of sensible objects; yet in the most proper sense of the word *think* (s), he certainly thought of both points and lines; for he appears to have made considerable progress in the science of geometry, in which he could not have proceeded a single step without a perfect knowledge of these things, on which the whole science is built. It is not therefore true, that our thoughts or ideas, when analysed, always resolve themselves into such simple ideas as were copied from a precedent feeling or sentiment; for every mathematical figure of which we can think resolves itself into a point and motion; and a point having no parts and no magnitude, cannot possibly be the object of feeling to any of our senses. If, therefore, ideas alone be the objects of thought, we have refuted Mr Hume's position by the very method which he himself lays down; for we have produced an idea which is not derived either from a precedent feeling or a precedent sentiment. By sentiment, we suppose to be here meant that which by other philosophers is denominated consciousness; and of consciousness it is undeniable that nothing is the object but the actual energies of our own minds.

But ideas are not the only objects of thought. We have already given our reasons for restricting the word *idea* to that appearance which an object of sense, when reflected on, makes either in the memory or imagination. Such was undoubtedly its original signification; and had it never been used to denote other and very different objects, much error and perplexity would have been avoided, which now disgrace the science of metaphysics. Things may *themselves* be the objects of thought; and

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Things of which we can have no ideas may themselves be the objects of thought.

(s) *Thinking*, in the propriety of the English tongue, signifies that sort of operation of the mind about its ideas wherein the mind is active; where it, with some degree of voluntary attention, considers any thing. *Locke*.

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and when that is the case, to think of their *ideas*, were it possible to do so, would be worse than useless; for we may certainly know a man better by looking at himself than by looking at his picture. Of things which are *themselves* the objects of thought, we have either a *direct* or a *relative* knowledge. We know directly the actual operations of our own minds by the most complete of all evidence, that of consciousness; and we have a *relative* notion of mathematical points and lines: but neither of mental energies nor of these external things (τ) can we possibly have any *idea*.

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We have
only rela-
tive notions
of some
things,
† *Essays on
the Active
Powers of
Man.*

It is well observed by Dr Reid †, that our notions both of body and mind are nothing more than relative. "What is body? It is, say philosophers, that which is extended, solid, and divisible. Says the querist, I do not ask what the properties of body are, but what is the thing itself? let me first know directly what body is, and then consider its properties. To this demand I am afraid the querist will meet with no satisfactory answer; because our notion of body is not direct, but relative to its qualities. We know that it is something extended, solid, and divisible, and we know no more. Again, if it should be asked, what is mind? It is that which thinks. I ask not what it does, or what its properties are, but what it is? To this I can find no answer; our notion of mind being not direct, but relative to its operations, as our notion of body is relative to its qualities (υ)."

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About
which,
however,
we can rea-
son with
the utmost
precision:

Our notion of a mathematical point is of the very same kind. What is a point? It is, says Euclid, that which hath no parts and no magnitude. Replies the querist, I ask not either what it has or what it has not let me first know what it is? To this second question, it might perhaps be answered, that a mathematical

point is that which by motion generates a line. But, rejoins the querist, I am not inquiring what it generates; give me a direct idea of the point itself? or, if that cannot be done, as surely it cannot, tell me what its offspring a line is? A line, says Euclid, is length without breadth. I have no idea, replies the querist, of length without breadth. I never felt an *impression* from a sensible object which did not suggest length, breadth, and thickness, as inseparably united; and I can have no idea which is not the *copy* of a former *impression*. To assist the querist's conception, it may be said that lines are the boundaries of a superficies, and that superficies are the boundaries of a solid body; but of a solid body every man has a clear and direct idea, in the most proper sense of the word. Here then are several things, viz. points, lines, and superficies, of not one of which is it possible to form a direct notion; and yet we know them so thoroughly, from the relation which they bear to other objects, that we can reason about them with a precision and certainty which only the mathematical sciences admit.

The great advantage of these sciences above the And such
moral, Mr Hume himself expressly admits: but he is power.
attributes it to a wrong cause, when he says it consists in this, that the "ideas of the former being *sensible* are always clear and determinate;" for we see that the notion of a point or of a line is merely relative, and cannot possibly be the copy of a sensation, or, in his language, of a sensible impression. If then we have clear and determinate notions of points and lines, and may reason about them without ambiguity, as he acknowledges we may, what is there to hinder us from having an equally clear and determinate notion of power, or from reasoning about it with as little ambiguity (v)? Why, says he, we are not conscious of power. And to prove this position, which needs no proof, he
3 U 2 makes

(τ) By calling mathematical points and lines external things, we do not mean to attribute to them any corporeal existence. We know well that they are merely creatures of the mind, and that if there were no mind, they could have no existence. But twenty men may at the same instant have a notion of the same lines and the same points; and therefore these lines and points have an existence independent of, and external to, any *one* mind, at least to any *one human* mind. The objects, however, of which a man is conscious, are in no sense whatever external, for they are present to no human mind but his own.

(υ) The opinions of philosophers concerning corporeal and spiritual substances shall be considered more fully hereafter. In quoting from Dr Reid on another subject, we have been obliged to anticipate his opinion, which will be found to be not more modest than just.

(v) "There are some things of which we can have both a direct and relative conception. I can directly conceive ten thousand men, or ten thousand pounds, because both are objects of sense, and may be seen. But whether I see such an object, or directly conceive it, my notion of it is indistinct; it is only that of a great multitude of men, or of a great heap of money; and a small addition or diminution makes no perceptible change in the notion I form in this way. But I can form a relative notion of the same number of men or of pounds by attending to the relations which this number has to other numbers greater or less. Then I perceive that the relative notion is distinct and scientific; for the addition of a single man, or a single pound, or even of a penny, is easily perceived. In like manner, I can form a direct notion of a polygon of a thousand equal sides and equal angles. This direct notion cannot be more distinct when conceived in the mind, than that which I get by sight when the object is before me; and I find it so indistinct that it has the same appearance to my eye, or to my *direct* conception, as a polygon of a thousand and one, or of nine hundred and ninety-nine sides. But when I form a *relative* conception of it, by attending to the relation it bears to polygons of a greater or less number of sides, my notion of it becomes distinct and scientific, and I can demonstrate the properties by which it is distinguished from all other polygons. From these instances it appears, that our relative conceptions of things are not always less distinct, nor less fit materials for accurate reasoning; than those that are direct; and that the contrary may happen in a remarkable degree."

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makes many observations that, however just, might certainly have been spared. Of these one is, that "a man suddenly struck with a palsy in the leg or arm, or who had now lost these members, frequently endeavours at first to move them, and employ them in their usual offices. Here he is as much conscious of power to command such limbs, as a man in perfect health is conscious of power to actuate any member which remains in its natural state and condition. But consciousness never deceives. Consequently, neither in the one case nor in the other are we ever conscious of any power." This is true; we never are conscious of any power; but we are frequently conscious of actual energies: and the man who, after being suddenly struck with a palsy, endeavours in vain to move his leg or arm, is as conscious of energy as he who in health makes the attempt with success. Nor let it be imagined that his consciousness deceives him; for, as Mr Hume justly observes, consciousness never deceives. He is certain of the *energy*, but finds by experience that the *instrument* of this energy has suddenly become disordered and unfit for its usual office. In this and this alone consists the difference between the paralytic and the man whose limbs are sound. The one may be as conscious of energy as the other, and his consciousness may be equally infallible. What then is this energy? Mr Hume will not say that it is an *idea*, for it is not the copy of any antecedent impression; besides, he has somewhere allowed that ideas are never active. Is it then a substance? Impossible! for it is not permanent: and we believe no man will venture to affirm, or even to suppose, that the same substance can be repeatedly annihilated, and as often created. Is it then the occasional exertion of some substance? This must be the truth; for no other supposition remains to be made. If so, that substance must be possessed of *power*; for a capacity of exerting actual energy is all that is meant by the word *power*. — "Wherever there is a *capability* of energy or exertion, there must be *power*; for though there can be no exertion without power, there may be power that is not exerted". Thus a man may have *power* to speak when he is silent; he may have power to rise and walk when he sits still. But though it be one thing to *speak* and another to have the *power* of speaking, we always conceive of the power as something which has a certain relation to the effect; and of every power we form our notion by the effect which it is able to produce. Nor is it only in speaking and moving his limbs that a man is conscious of energy. There is as much energy, though of a different kind, in *thinking* as in *acting*. Hence the powers of the human mind have been divided into active and speculative. By the former we move the body; and by the latter we see, hear, remember, distinguish, judge, reason, and perform upon our notions and ideas every other operation which is comprehended under the general word *to think*."

* Reid's Essay
says on the
Active
Powers of
Man.

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Locke's passive power
an improper expression.
† Essay, book ii.
chap. 21.

Mr Locke† has introduced into his theory of power another distinction than that which we have made between active and speculative powers. Observing by our senses, under which on this occasion memory is certainly included, various changes in objects, we collect, says he, a possibility in one object to be changed, and in another a possibility of making that change, and so come by that idea which we call power. Thus

we say that fire has a power to melt gold, and that gold has a power to be melted. The first he calls *active*, the second *passive*, power. But to say that the *possibility* of being changed is *power*, seems to be a very improper mode of speaking, and such as may lead to consequences which the excellent author certainly held in abhorrence. It tends to make unwary readers imagine that the passive subject is as necessary to the existence of power, as the active being of which power is an attribute; but if the universe had a beginning, and if its Creator be immutable, two propositions which Mr Locke firmly believed, there certainly was power when there was no change, nor any thing existing which was capable of change. He owns, indeed, that active power is more properly called power than the other; but we see no propriety at all in passive power. "It is (in the language of Dr Reid) a powerless power, and a contradiction in terms."

But though Locke here uses improper terms, he has other observations with which we have the honour fully to agree, and which lead to consequences the reverse of that impiety which seems to follow from the notion of *passive* power. He observes, that "we have from body no idea at all of thinking, nor any idea of the beginning of motion. A body at rest affords us no idea of any active power to move; and when it is set in motion itself, that motion is rather a passion than an action in it. For when the ball obeys the stroke of a billiard stick, it is not any action of the ball, but a passion: also, when by impulse it sets another ball in motion that lay in its way, it only communicates the motion it had received from another, and loses in itself so much as the other received; which gives us but a very obscure idea of an active power of moving in body, whilst we observe it only to transfer, but not to produce any motion. So that it seems to me, we have from the observation of the operation of bodies by our senses but a very imperfect obscure idea of active power, since they afford us not any idea in themselves of the power to begin any action either of motion or thought." He thinks it evident, however, "that we find in ourselves a power to begin or forbear, continue or end, several actions of our minds and motions of our bodies, barely by a thought or preference of the mind ordering, or, as it were, commanding, the doing or not doing such or such a particular action. This power which the mind has thus to order the consideration of any idea, or the forbearing to consider it, or to prefer the motion of any part of the body to its rest, and *vice versa* in any particular instance, is that which we call *will*. The actual exercise of that power, by directing any particular action, or its forbearance, is that which we call *volition* or *willing*."

According to Mr Locke, therefore, the only clear notion or idea we have of power is taken from the power which we find in ourselves to give certain motions to our bodies, or certain directions to our thoughts; and this power in ourselves can be brought into action only by willing or volition. This is exactly our doctrine; where we have endeavoured to prove, that without the consciousness of actual energy in ourselves, we never could have acquired any notion at all of power from observing the changes which take place among external objects. But if this be so, if the *power*, of which alone we know any thing, can be brought into

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standing can possess
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into action only by willing or volition, and if will necessarily implies some degree of understanding, as in us it certainly does, it comes to be a question of the first importance, whether any being which possesses not will and understanding can be possessed of real power, or be the efficient cause of any action. This question we feel ourselves compelled to answer in the negative. If we had not will, and that degree of understanding which will necessarily implies, it is evident that we could exert no power, and consequently could have none: for power that cannot be exerted is no power. It follows also, that the power, of which alone we can have any distinct notion, can be only in beings that have understanding and will. Power to produce any effect, implies power not to produce it; and we can conceive no way in which power may be determined to one of these rather than the other in a being that has not will. We grow from infancy to manhood; we digest our food, our blood circulates, our heart and arteries beat; we are sometimes sick and sometimes in health: all these things must be done by the power of some agent, but they are not done by our power. And if it be asked how we know this? the answer is, because they are not subject to our will. This is the infallible criterion by which we distinguish what is our doing from what is not; what is in our power from what is not. Human power can be exerted only by will: and we are unable to conceive any active power to be exerted without will. If, therefore, any man affirms that a being may be the efficient cause of an action which that being can neither conceive nor will, he speaks a language which we do not understand. If he has a meaning, he must take the words *power* and *efficiency* in a sense very different from ours; for the only distinct notion, indeed the only notion which we can form, of real efficiency, is a relation between the cause and the effect similar to that between us and our voluntary actions. It seems therefore most probable, that such beings only as have some degree of understanding and will can possess active power, and that inanimate beings must be merely passive. Nothing which we perceive without us affords any good ground for ascribing active power to any inanimate being; and we can as little conceive such a being possessed of power as we can conceive it capable of feeling pain. On the other hand, every thing which we discover in our own constitution, leads us to think that active power cannot be exerted without will and intelligence; and to affirm that it can, is to affirm what to us at least is a contradiction in terms.

To this reasoning, which is Dr Reid's*, and which to us appears unanswerable, we have heard it objected, that a man born blind has the same evidence for the non-existence of colour that is here urged for the impossibility of power being exerted without will and understanding. If the objection had not been made by a very acute man, we should have deemed it altogether unworthy of notice; for between the two cases supposed to be similar there is hardly any analogy. A man born blind has no notion whatever of colour. If you describe it to him in the best manner that you can, and refer it to any of the senses which he possesses; if you say that it is the object of feeling, and that by feeling it one may perceive things at the distance of many miles; the blind man has reason to say that you

are uttering a proposition which he knows with the utmost certainty cannot possibly be true. But if you tell him that colour is the object of the sense of sight, a sense which he possesses not; that it has not the least resemblance to the objects of the other senses; and that persons endowed with the sense of sight perceive coloured objects at the distance of many miles; the blind man cannot know whether what you say be true or false, because he has no idea or conception of the things of which you speak. This is not the case with respect to power; for every man who has reflected on the operations of his own mind has a very distinct notion of power, and knows perfectly, that to the actual exertion of the only power which he can conceive, will and understanding are necessary. Should it be said that there may be power altogether different from that of which we have a distinct conception, we think it sufficient to reply, that of a thing which cannot be conceived nothing can be either affirmed or denied; that activity exerted without will and understanding, ought not to be called an exertion of *power*, because power is the name already appropriated to the attribute of a being by which he can do certain things if he wills; that as we can form no notion of a real efficient cause which has not will and understanding, so we have no reason to believe that such a cause anywhere exists; and to say that power, such as we can conceive, may be exerted without will and understanding, is as great an absurdity as to say that there may be velocity without space.

But if active power, in its proper meaning, requires a subject endowed with will and intelligence, what shall we say of those active powers which philosophers teach us to ascribe to matter, the powers of corpuscular attraction, magnetism, electricity, gravitation, and others? These powers, as they are called, shall be considered when we treat of the nature and source of corporeal motion. In the mean time, it is sufficient to observe, that whatever the agents may be in the operations of nature, whatever the manner of their agency or the extent of their power, they depend upon the first cause, and are all under his control.

CHAP. VII. Of TRUTH, and the different SOURCES of EVIDENCE.

SECT. I. Of Truth.

By pursuing these inquiries in the order which to us appears most natural, we are now led to the contemplation of those faculties of the human mind of which *truth* is properly the object. But what is *truth*? This was a famous question among the Greek sophists; which had been so often agitated, and to which so many absurd answers had been given, that it came at last to be doubted by men of the world whether a satisfactory answer could be given, or indeed whether the matter was worthy of investigation. It is well known, that among the ancient philosophers there was a sect called from their principles *Sceptics*, and from their founder *Pyrrhonians*, who openly avowed their opinion that *truth*, like virtue, is nothing but a name; that all things are equally true, or rather equally doubtful; and that it is in vain for man to hope for certainty in any inquiry in which he can be engaged. Such

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fined.

scepticism as this no modern philosopher has professed; but many have had enough of it to make sober men hesitate about defining truth, and even insinuate that of truth no definition can be given. This surely is a mistake. If truth cannot be defined, it still wanders at large and in disguise, and vain must be the pursuit of every man who endeavours to obtain it; he is pursuing he knows not what.

So obvious and so solid is this reflection, that almost every philosopher of merit who has lately written on the nature of evidence has begun his work, if not with a formal definition, with something at least equivalent to a definition of the object of his pursuit. To repeat all these definitions could serve no other purpose than to swell this article to a disproportioned bulk, and to perplex perhaps the mind of the reader. We shall therefore content ourselves with that which

is given by Mr Wollaston. "Those propositions (says he) are true which represent things as they are: or, truth is the conformity of those words or signs by which things are expressed to the things themselves." Notwithstanding the objections of a very learned and acute writer (w), this is the best definition of *truth* which we have met with in any language. It is concise and perspicuous. It comprehends all kinds of truth, as well that which is merely mental, the subject of silent contemplation, as that which is communicated either by written language or by the living voice: and it makes truth itself immutable, as depending not upon the arbitrary constitution of this or that individual, or even of the whole human race (x), but upon the nature of things as established by their Almighty Creator.

According to this definition, every proposition

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Every proposition either true or false.

(w) Dr Tatham having asked, with a contemptuous air, How imperfect and illogical is the definition of truth given by Wollaston? proceeds, though not to define, to describe or characterise it himself. "Truth (says he) is of the nature and essence of God, like him *incomprehensible* in the whole, and *ineffable* in its sublimer parts. For these and other reasons it cannot admit of an *adequate definition*. And who, in the beginning of his researches, should presume to define that which, after all his longest and best conducted labours, he can only hope partially, and often imperfectly, to comprehend; and of which an important part can neither be *directly* expressed nor *directly* understood? We may indeed esteem ourselves highly favoured by the Author and finisher of all truth, if, at the end of our researches, we shall be able any way to understand, to define, and to apply, a few particular portions and detachments of it, and to guard them from ERROR and corruption. When upon a solemn occasion the question was put to our Lord by a Roman governor, *What is TRUTH?* though it was what he fully and perfectly knew, and what he came purposely and professedly to teach, he did not define it. He knew that definition was never the best method of instruction; and that in its common use and application it was seldom the friend of truth. Philosophically viewed, words do not constitute truth; they are only the vocal instruments by which it is communicated, or the written signs by which it is recorded. By an inquirer, therefore, things are to be examined rather than words defined. By a teacher, things are to be conveyed by words in some form or other, which are doubtless to be explained to the understanding, if not sufficiently understood before. But *explanation* is one thing, and *definition* quite another. Explanation is the *first* office of a teacher: Definition, if it be good, is the *last* of the inquirer, after the truth be found; and is then the most *advantageously* employed by the teacher, when his previous instructions have prepared him for it. GOD is a mind, and TRUTH is consequently an *attribute* of MIND. To the SUN, declaring at his rising a marvellous instrument, He, by whom all things were made, hath delegated the power of enlightening the *material* system; whilst he hath reserved to HIMSELF the office which is more suitable to his nature, of giving light and knowledge, by his eternal TRUTH, to the *mind* of man. But whether he act through the instrumentality of his creatures, or more *immediately* from himself, he is uniform and consistent in his operations; so that one part of his divine economy is always illustrative of another. As the SUN sheds his *light* over the material creation to be apprehended by the eye, TRUTH is the *light* shed down from heaven to be apprehended by the intellect, given to illumine every subject, natural and moral, corporeal and spiritual, so far as they are qualified by their different natures to convey it to the human mind, or rather perhaps so far as the human mind is qualified to receive it from them." *The Chart and Scale of Truth*, vol. I.

This passage, of which some parts are certainly not remarkable for perspicuity, seems to be descriptive, not of *truth* in the common acceptation of the word, but of *all knowledge* human and divine, of which indeed no adequate definition can be given. *Truth*, as here used, seems to be opposed to *ignorance*; as used by Mr Wollaston and others it is opposite to *falsehood*. In this last sense it may certainly be *explained*, if not defined: and if the learned lecturer will allow that Mr Wollaston has given a good *explanation* of the word *truth* as opposed to *falsehood*, we shall not quarrel with him or any man about the propriety of an expression. We have called it a *definition* of truth; because it was so called by the author from whom it is taken.

(x) Dr Beattie, in his elegant essay, has given a definition of truth very different from this, though it is possible that his meaning may be the same with Mr Wollaston's. "I account that to be *truth* (says he) which the constitution of our nature determines us to believe; and that to be *falsehood* which the constitution of our nature determines us to disbelieve." But if truth be really *immutable*, as he teaches or wishes to teach, it must depend upon the nature of things, and not upon the instinctive impulse of any particular constitution. It is always difficult, often impossible, to distinguish between the constitution of our nature, as it came from the hand of God, and the same constitution as it is moulded by arbitrary and capricious associations of our own. A sincere member of the Church of Rome certainly believes the doctrine of transubstantiation. How he may do so we have already shown. Were all mankind sincere members of that church, it would be said

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Of Truth. which can be expressed or apprehended is necessarily either true or false, whether its truth or falsehood be perceived or not either by him who hears or by him who utters it. All propositions are either affirmative or negative; but before any thing can with certainty be affirmed or denied of another, we must know those things as they are in themselves, as well as the established use of the signs by which they are expressed. He who affirms or denies without this knowledge, speaks at random, and has no distinct meaning.

122 Every human faculty concerned in the acquisition of truth. Every faculty which we possess is in some way or other an instrument of knowledge; for we know by our senses, by our memory, and by our intellect. Every one of our faculties, therefore, is concerned in the acquisition of truth, and furnishes the mind with the materials of propositions. These propositions are indeed of various kinds; but they are all certainly true or certainly false, though the *certainty* of the truth or falsehood of every one it is not always in our power to perceive.

123 Diversity of belief affects not the truth of what is believed. When a man affirms that red is a quality inherent in a soldier's coat, he utters a proposition which every one of the vulgar firmly believes to be true, but which every philosopher knows to be false. This diversity of belief, however, affects not the truth of the proposition itself. All mankind know that it is either true or false, independent of them or their perceptions; and it is easy, by a few optical experiments and by an explanation of terms, to convince them all, that what they have agreed to call *red* is no quality inherent in external objects, but only a sensation caused by the impulse of certain rays of light reflected from certain objects to the eye of the percipient. The contrariety therefore in this case of vulgar to philosophical belief, does not result from any ambiguity in the nature of truth itself, but from the different means of perception which the clown and the philosopher possess.

Again, were a man looking at a red and a green object, to affirm that they are both of the same colour, he would affirm what in one sense may be true, what in another is undoubtedly false, and what in a third may be either true or false. If it be his meaning that the two objects give to him the same sensation, he may know with the utmost certainty that what he says is true; if he mean that they affect all mankind precisely as they affect him, he utters what all mankind with the most absolute certainty know to be false; if he mean that the texture of the two bodies (that particular disposition of parts on their surfaces which makes them reflect certain rays of light and absorb others) is exactly similar, so as that the one must reflect the very same kind of rays with the other, he utters what all mankind must *believe* to be false, though still it is *possible* that what he affirms may be true. This diversity of belief affects not the truth itself. The two objects are what they are by whomsoever perceived, or whether perceived or not; the rays of light reflected by

each are what they are, whether they fall upon this, upon that, or upon any eye; and the sensation communicated to this singular man is certainly what he is conscious it is, as those of the rest of mankind are with equal certainty what they are conscious of. This being the case, it is obvious and undeniable, that the organs of sight in this individual of the human race are somehow differently formed from those of other men; and the only question which can occasion a doubt in the mind of the sceptic is, whether his or their eyes be so formed as to represent things falsely? for that by the one or the other things are falsely represented, is as evident as that two contradictory propositions cannot both be true. Now, though, for any thing we know it is certainly possible, as to us it appears not to imply any contradiction, that the eyes of but one man are formed in a manner suitable to their objects, whilst the eyes of all other men are formed to deceive them; yet the contrary is so highly probable, that no man really doubts of it any more than he doubts whether three and two be equal to five.

This last proposition is indeed said to express a truth absolutely certain, whilst the former expresses a truth which is called morally certain: not that there is any difference or degrees of certainty in the nature of truths themselves; the only difference is in our power of perceiving them. That three and two are equal to five, is said to be an absolute truth; because we perceive the whole of it as it is in itself, and are convinced that every intelligence from the highest to the lowest who understands the terms in which it is expressed perceives it as we do: whereas of *moral* or *physical* truths, as they are called, we only perceive a part, and may therefore mistake for want of evidence. Thus, in the case of the two objects exhibiting the same colour to one man, whilst they exhibit different colours to all other men, could we see into the objects themselves, and comprehend them immediately with our intellect as we comprehend our own ideas, it might, and no doubt would, appear as palpable a contradiction to say that the particular disposition of the parts on their surfaces, which reflect the rays of light, are the same in both, as it is now to affirm that three and two are not equal to five. Between truth and falsehood there is no medium. All truths are in *themselves* equally certain; and to the Supreme Being, who knows the nature of every thing more fully and intimately than we know our own ideas, they all *appear* equally certain: but yet we may without absurdity speak of *probable* truth as well as of *certain* truth, provided always that we make the difference to result, not from the nature of things, but from the power of our understanding, which comprehends the one kind of truth wholly and the other only partially.

There is another division made of truth into that which is eternal and necessary, and that which is temporary and contingent. Though we do not approve

124 Why some truths are said to be absolutely and others morally certain.

and thought, "that the constitution of human nature determines men to believe transubstantiation:" a doctrine which, though it is rejected by millions, Pere Buffier has laboured hard to reconcile with common sense. Yet it is certain that the same body cannot be in different places at the same time; and that therefore transubstantiation must be false, though believed by all mankind. Our *believing* any thing does not make it true, nor our *disbelieving* any thing make it false. We must, indeed, *act* according to our belief; but in every instance truth and falsehood would have been what they are, though we had never existed.

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of applying the epithets *temporary* and *eternal* to any thing but real existences, yet as this manner of speaking has been used by all philosophers, we shall give instances of each kind of truth, and endeavour to ascertain in what the distinction consists. "The three angles of a plain triangle are equal to two right angles," is a proposition expressive of a necessary and eternal truth. "The world exists," is a contingent and temporary truth. Here it is obvious, that if both these propositions be true, there is no distinction between them, so far as mere *truth* is concerned; for truth admits not of degrees of comparison. It is however said, that the first proposition depends not upon time, or will, or any thing else; and that the Supreme Being himself could not make it false: whereas it is certainly possible, that he who created the world could annihilate it, and thus reduce what is now a truth to an absolute falsehood. This difference between the two propositions is thought a sufficient ground for calling the former a *necessary* and *eternal* truth, and the latter a *temporary* and *contingent* truth. But is the difference itself real? In the present instance we cannot think that it is: for if the right angles and triangles, which constitute the materials of the former proposition, be real corporeal things, they may be annihilated as well as the rest of the world; and then the truth of the proposition will cease, for there can be neither equality nor inequality between nonentities. If the angles and triangles be merely ideas in the mind of a rational being, it is not to be denied that the proposition must be true, independent of all *will*, whenever those ideas exist, *i. e.* whenever right angles and triangles are *thought upon*; but if all reasonable creatures were to be annihilated, and the Supreme Being never to think of triangles, the proposition would unquestionably cease to be either true or false. The world may indeed be annihilated; but it certainly is not annihilated whilst any one creature exists to contemplate even that which is called *necessary* and *eternal* truth: and therefore whilst any truth exists in a mind not divine, it must be necessarily true that the world exists; for the individual being by which truth is perceived would then constitute the whole world.

But if in a somewhat different manner we compare the former of these propositions with this—"The solar system consists of the sun and at least seven primary planets"—we shall at once perceive the difference

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between necessary and contingent truths. Both propositions we know to be true at this moment: but there is this difference between them, that a plain triangle can neither actually exist at any period of duration, nor be conceived by any one mind divine or human, of which the three internal angles are not precisely equal to two right angles; whereas the solar system may easily be conceived, and might certainly have been formed, with a smaller number of primary planets rolling round the central fire. This needs no proof; as it is well known, that till very lately we conceived the system to consist of the sun and only six primary planets; and it has been already shown, that whatever we can positively conceive may possibly exist. Thus, then, every proposition, of which the contrary is clearly and distinctly perceived to be impossible, is a *necessary* truth; and it may likewise be said to be *eternal*, because at every period of duration it must of necessity when thought upon be perceived to be true: On the other hand, every proposition of which the contrary may be clearly and distinctly conceived, is, if true, only a *contingent* truth, because its contrary might have existed; and it may likewise be called *temporary*, because what might have been false in time past may yet be false in time future.

Though all our faculties (our senses, our memory, and our intellect) furnish materials for propositions, and are therefore all subservient to the investigation of truth; yet the perception of truth, as it is in itself, is commonly ascribed to our rational faculties; and these have by Locke and others been reduced to two—reason and judgment. The former is said to be conversant about certain truths, the latter chiefly about probabilities.

Some late philosophers of great merit, dissatisfied with this analysis of the intellect, have added to reason and judgment a third faculty, to which they have given the name of *common sense*, and of which the proper object is such truths as neither admit nor stand in need of evidence. By *common sense* they mean, "that degree of judgment which is common to men with whom we can converse and transact business." Whether the introduction of such a term into metaphysics was proper or improper, we do not think it of importance to inquire. According to this definition of it, which is Dr Reid's, it differs not from the *reason* (x) and *judgment* of Locke; agreeing with the former when its

(x) This is expressly acknowledged by Dr Reid. "It is absurd (says that able and candid writer) to conceive that there can be any opposition between reason and common sense. It is indeed the first-born of reason; and as they are commonly joined together in speech and in writing, *they are inseparable in their nature*. We ascribe to reason two offices or two degrees: The first is to judge of things self-evident; the second to draw conclusions that are not self-evident from those that are. The first of these is the province, and the sole province, of common sense; and therefore it *coincides with reason in its whole extent*, and is only *another name* for one branch or one degree of reason." Pere Buffier talks nearly the same language; but Dr Beattie expresses himself very differently. "That there is a real and essential difference between these two faculties; that common sense cannot be accounted for by being called the *perfection of reason*, nor reason by being resolved into *common sense*; will appear (he thinks) from the following remarks. 1. We are conscious, from internal feeling, that the energy of understanding, which perceives intuitive truth, is different from that other energy which unites a conclusion with a first principle by a gradual chain of intermediate relations. 2. We cannot discern any necessary connection between reason and common sense." Nay, he says, "That we often find men endued with the one who are destitute of the other:" and he instances dreams and certain kinds of madness where this is the case; adding, that a man who believes him-

self

Of Intuitive Evidence and Demonstration its object is certain truth, and with the latter when it is conversant about probabilities. Nothing indeed is more evident, than that in the assent of the mind to every proposition, some energy of the judgment is exerted; and upon every proposition not self-evident, reasoning of some kind or other must be employed to procure that assent. Instead therefore of perplexing ourselves and our readers with various analyses of the human understanding, or rather with various names to what after all is perhaps but one individual power, it will surely be of more importance to the cause of truth to examine the different sources of evidence by which the assent of the reason, or judgment, or common sense, is determined.

Under the article *Logic* it was observed, that *intuition*, *experience*, and *testimony*, are each a sufficient ground of judgment; but they are not the only grounds. *Consciousness* is certainly one source of evidence, perhaps the most complete of any; and, in a low degree, *analogy* is another. Of *consciousness* we have already treated, but of *analogy* we have yet said nothing: and though we might (for an account of *intuition*, *experience*, and *testimony*) refer our readers to the article *Logic*, where they are accurately though concisely explained, we shall, without repeating what has been already said, add a few words on each, as well to complete the present article as to supply the deficiencies of the former.

SECT. II. Of Intuitive Evidence and Demonstration.

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Intuitive
evidence,
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INTUITIVE evidence is that which arises from the comparison of two or more ideas or notions when their agreement or disagreement is perceived immediately, without the intervention of any third idea or notion. Of this kind is the evidence of these propositions: One

* Campbell's and four make five*; things equal to "the same thing are equal to one another; the whole is greater than any of its parts;" and in a word, all the axioms in arithmetic and geometry. All these are in reality propositions in which the subject and predicate appear upon comparison to be nothing more than the same thing taken in different views or expressed by different terms. In fact, they are all in some respect reducible to this axiom, "Whatever is, is." We do not say that they are deduced from it; for they have in themselves that original and intrinsic evidence which makes them, as soon as the terms are understood, to be perceived intuitively. And if they be not thus perceived, no deduction of reason will ever confer on them any additional evidence. But though not deduced from

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the general axiom, they may be considered as particular exemplifications of it; inasmuch as they are all implied in this, that the properties and relations of our clear and adequate ideas can be no other than what the mind clearly perceives them to be.

It may perhaps be thought, that if axioms were propositions perfectly identical, it would be impossible by their means to advance a single step beyond the simple ideas first perceived by the mind. And it would indeed be true, that if the predicate of the proposition were nothing but a repetition of the subject under the same aspect, and in the same or synonymous terms, no conceivable advantage could be made of it for the furtherance of knowledge. Of such propositions as these, for instance, "seven are seven, eight are eight, the three angles of a triangle are the three angles of a triangle, two right angles are two right angles," it is manifest that we could never avail ourselves for the improvement of science: But when the thing, though in effect coinciding, is considered under a different aspect; when that which is single in the subject is divided in the predicate, and conversely; or when what is a whole in the one is regarded as a part of something else in the other; such propositions lead to the discovery of innumerable and apparently remote relations. It is by the aid of such simple and elementary principles that the arithmetician and the algebraist proceed to the most astonishing discoveries. Nor are the operations of the geometrician essentially different: for to this class belong all propositions relating to number and quantity; that is, all which admit of mathematical demonstration. If the truth of a mathematical proposition be not self-evident; in other words, if the subject and predicate do not appear at first sight to be different names for the same thing, another term must be found that shall be synonymous to them both. Thus, to prove that the three internal angles of a right-lined triangle are equal to two right angles, I produce the base of the triangle; and by a very short process I discover that the exterior angle so formed is equal to the two interior and opposite angles. By a process equally plain and short, I perceive that the exterior angle and the interior adjacent angle are equal to two right angles: But I have already seen, that the exterior angle is neither more nor less than the two interior and opposite angles under a different aspect; whence it appears that the three internal angles of the triangle are nothing else than two right angles under a different aspect. In a word, all demonstration is founded on first principles or primary truths, which

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Every demonstration a series of propositions intuitively evident.

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self made of glass, shall yet reason very justly concerning the means of preserving his supposed brittleness from flaws and fractures." Surely these are strange remarks. Dreams and madness have hitherto been supposed to originate in the imagination, or, as it was denominated by the ancient philosophers, the *phantasia*: and when the ideas or forms which are there treasured up are disarranged or absurdly compounded, a dreaming sane man or a waking madman, if he reason at all, must reason from absurd principles; not, however, through any defect of common sense, but from a disorder in that region of the brain, upon which the *phantasia* more immediately depends. Of his first remark, we can only say, that to us it appears to be the reverse of truth. In every proposition which admits of demonstration, we are conscious that the conclusion is united with the first principle by a repetition of the very same energy of the understanding which perceives intuitive truth. That this is the case in every one of Euclid's demonstrations, we appeal to every mathematical reader; and why it must be so, we shall by and by endeavour to evince.

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Evidence
and De-
monstration

neither admit nor stand in need of proof, and to which the mind is compelled to give its assent by a bare intuition of the ideas or terms of which these primary truths are composed. Nothing is susceptible of demonstration, in the rigid sense of the word, but general, necessary, and eternal truths; and every demonstration is built upon intuition, and consists in a series of axioms or propositions of the very same kind with the first principle or truth from which the reasoning proceeds. That propositions formerly demonstrated are taken into the series, doth not in the least invalidate this account; inasmuch as these propositions are all resolvable into axioms, and are admitted as links in the chain; not because necessary, but merely to avoid the useless prolixity which frequent and tedious repetitions of proofs formerly given would occasion. But it is obvious that such truths only as result from the comparison of ideas and notions are necessary; and of course that such truths only are capable of strict demonstration. The truths which relate to real existences are all contingent, except that which affirms the existence of the Supreme Being, the Parent of all truth.

The mathematical sciences, categorical logic, and that part of metaphysics which demonstrates the being of God, are therefore the only branches of human knowledge which admit of strict demonstration. The longest demonstration in the mathematical sciences may be traced to this general and necessary truth, "Whatever is, is," or to some particular exemplification of it: the longest train of categorical syllogisms terminates in this general principle, "What is affirmed or denied of a whole *genus*, may be affirmed or denied of all the *species* and all the *individuals* belonging to that *genus*:" and the metaphysical demonstration of the being of God rests upon this foundation, "Whatever had a beginning, had a cause." That these are truths absolutely certain, which can neither be proved nor called in question, every man may be satisfied, merely by attending to the ideas or notions which the terms of each proposition express. The two first are merely identical propositions, of the truth of which no man has ever pretended to doubt; and though the last is not identical, it is a necessary and self-evident truth, as its contrary implies, that in the same thing there is power and no power, change and no change, action and inaction, at the same instant.

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It is by intuition that we acquire all our notions of relation.

Before we dismiss the subject of intuition, it may not be improper to observe, that it is by this faculty or power of the mind contemplating its ideas, and comparing one idea with another, that we acquire all our notions of relation; such as *identity* and *diversity*, *resemblance*, *coexistence*, relations of *space* and *time*, relations of *quantity* and *number*, of a *cause* to its *effect*, and many more which it would be useless as well as tedious to enumerate.

SECT. III. Of Experience and Analogy.

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Experience, the result of repeated observations.

It has been just observed, that intuition and demonstration are applicable only to general and necessary propositions, of which the contrary are not only false, but absurd and impossible. The great business of life, however, is with facts and contingent truths, which admit not of demonstration, but rest upon other evidence. The senses, external and internal, are the in-

lets to all our knowledge of facts; and the memory is the storehouse where that knowledge is preserved. Of what a man sees or feels, he can at the instant of seeing or feeling entertain no doubt; and whilst the ideas of what he has seen or felt, with all their associated circumstances, remain vivid and distinct in his memory, he is conscious that he possesses so much real knowledge. But all our knowledge, as it is derived from the senses, is of particular facts or particular truths; and the man who has in certain circumstances observed one particular phenomenon, for the existence of which he perceives no necessity, has not sufficient ground to conclude, that in similar circumstances similar phenomena will always occur. Milton, who surpassed the greater part of his contemporaries in philosophical science almost as far as he has surpassed all succeeding poets in the sublimity of his genius, represents Adam, when first falling asleep, as under apprehensions that he was about to sink into his original state of insensibility:

Of Experience and Analogy.

"Gentle sleep

"First found me, and with soft oppression seiz'd

"My droused sense, untroubled; though I thought

"I then was passing to my former state

"Insensible, and forthwith to dissolve."

Apprehensions similar to these would take place in his mind when he first perceived that darkness had overspread the earth. In his circumstances, he could have no ground to expect that the sun when once set would rise again to relume the world, as he had not then experienced the alternate succession of light and darkness, and probably knew not whence light proceeds. After some time, however, having observed day and night regularly to succeed each other, these two appearances, or the ideas of them, would be so associated in his mind, that each setting sun would suggest the idea of next sun-rising, and lead him to expect that glorious event with the utmost confidence. He would then consider the alternate succession of day and night as a law of nature, which might be affirmed in a proposition expressive of a certain truth.

This continued observation of the same event happening in the same or similar circumstances, is what we call *experience*; and it is the only evidence which we have for all the general truths in physics, even for those which we are apt to think intuitively certain*. Thus, that *milk* is white, and that *gold* is yellow, are supposed to be universal and necessary truths: but for any thing that we know, they may be particular truths; and they are certainly contingent, as the contrary to either of them may be supposed without absurdity. We have indeed always observed the milk of animals of every species *white*; and therefore the idea of *white* becomes a necessary part of our idea of the substance milk, of which we call whiteness an essential property. This, however, respects only the milk of those animals with which we are acquainted. But since the milk of all the animals with which we are acquainted, or of which we have heard, is white, we can have no reason to suspect that the milk of any new and strange animal is of any other colour. Also, since, wherever there has been the specific gravity, ductility, and other properties of *gold*, the colour has always been *yellow*; we conclude that these circumstan-

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Is the only evidence that we have for all the general truths in physics, even those which we think intuitively certain.

* Campbell's Philosophy of Rhetoric; and Priestley's Remarks on the Dr. Reid, &c.

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ence and
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Difference
between
experience
and analog
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ces are necessarily united, though by some unknown bond of union, and that they will always go together.

The proper proof, therefore, of such universal propositions as "that milk is white," "that gold is yellow," or "that a certain degree of cold will freeze water," consists in what is called an induction of *particular facts* of precisely the same nature. Having found, by much and various experience, that the same events never fail to take place in the same circumstances, the expectation of the same consequences from the same previous circumstances is necessarily generated in our minds; and we can have no more suspicion of a different event than we can separate the *idea* of *whiteness* from that of the other properties of *milk*.—When the previous circumstances are precisely the same, we call the process of proof by the name of *induction*, and expect the event from *experience*: but if they be not precisely the same, but only bear a considerable resemblance to the circumstances from which any particular appearance has been found to result, we call the argument *analogy*; and it is stronger in proportion to the degree of resemblance in the previous circumstances. Thus the milk of all the cows that we have seen, or upon which we have made the experiment, having been found nourishing, we confidently expect that the milk of all other cows will prove nourishing likewise; and this confidence of expectation is the result of uniform experience. But if, from having found the milk of all the animals with which we are acquainted to be nourishing, however different the nature of these animals; we infer that the milk of any strange animal will likewise be nourishing; the inference is drawn by analogy, and by no means carries with it the conviction of experience. A proof from *real* experience can leave no doubt in the mind (B); an argument from analogy always must. In the one case, we only infer that two events of precisely the same nature and in precisely the same circumstances have been produced by the same kind of cause; in the other, we infer that two events similar in most respects, though for any thing that we know dissimilar in others, have been produced by the same kind of cause; and it is obvious that between these cases the difference is great.

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The evi-
dence of
analogy in-
ferior to
that of ex-
perience.

Thus, after having observed that all the projectiles to which we have paid any attention—a stone thrown

from the hand, a ball from a gun, and an arrow from a bow—describe a certain curve, and are impelled in that curve by two powers acting in different lines of direction which form with each other a certain angle, we infer that all projectiles which on the surface of the earth describe the same curve are impelled by the same or similar powers acting in the same or similar lines of direction. This inference is the result of experience, and carries with it the fullest conviction to the mind. But when, from having observed that the curves described by the planets are of the same kind with those described by projectiles on the earth, Sir Isaac Newton inferred that these vast bodies are impelled in their orbits by forces of the very same kind, and acting in the same manner with the forces which impel a ball from a cannon or an arrow from a bow, his argument was founded only on analogy; and even that analogy is very remote. We know by experience that all projectiles which fall under our immediate cognisance are of the very same kind and in the very same circumstances; that every one of them has a tendency, from whatever cause, to the centre of the earth, and is preserved from falling by the force of projection; we know likewise that they are all moved thro' the medium of the atmosphere, which at the surface of the earth is considerably dense, and that a dense medium must occasion much resistance: But we do not *know* that the planets have a tendency to the centre of the sun, that they are preserved from falling into that luminary by a projectile force, or whether they move through a *medium* or *in vacuo*: so that we are not *certain* that the motion of the planets is perfectly similar to that of terrestrial projectiles in any other circumstance than the form of the curve which they all describe; and from this single case of coincidence no inference can be drawn which carries to the mind absolute conviction.

When a man reasons from *experience*, he infers, that what has uniformly happened hitherto, will happen always in the very same circumstances; or that what is known to be the cause of *various phenomena of the same kind* is the cause of every other phenomenon in *all respects* similar to these. Such an inference is founded on the united and complete evidence of sense, memory, and reason. When a man reasons from *analogy*, he infers, that what has *generally* happened hitherto,

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will

(Z) We say from *real* experience; because what is often taken for *experience*, and to human eyes has that appearance, is in fact nothing more than *analogy*. Thus a physician may have prescribed to ninety-nine patients labouring under the same disease the same remedy, and always with the same success. If so, he will think that he has experience of its utility, and will prescribe it again with the fullest confidence. Yet in this case he may be disappointed; for though the medicine be the same and the disease the same, there may be something in the constitution of the hundredth patient so different from that of the ninety-nine, that what was salutary to them may be pernicious to him. This does not detract from the evidence of experience: it only shows, that the circumstances of the case in which the medicine failed were different from those in which it succeeded. In such conclusions as are founded on a complete induction and uniform experience, every man expects the event with the last degree of assurance, and regards his past experience as a full *proof* of the future existence of that event: In other cases, where experience has been variable—or apparently variable—he knows that the induction has been incomplete, and therefore proceeds with caution. He weighs the opposite experiments; takes as complete a view as he can of the circumstances in which they were made; considers which side is supported by the greater number of experiments, and inclines to that side with doubt and hesitation. And when at last he fixes his judgment, the evidence exceeds not what is called *probability*. All probability, then, supposes an opposition of experiments and observations, where the one side is found to overbalance the other, and to produce a degree of evidence proportioned to the superiority.

Of Testi-
mony.

will happen again in circumstances *nearly similar*; or that what is known to be the cause of various phenomena of the same kind, is the cause of other phenomena in *some respects* similar to these. This inference is likewise founded on the united evidence of sense, memory, and reason: but here the evidence of sense is not complete, and it can be strengthened only by finding more facts of the same or of a similar nature.

SECT. IV. *Of Testimony.*

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Mankind
ready to
believe the
testimony
of each
other.

THE last source of evidence which we proposed to consider is *testimony*, or the report of men concerning events which have fallen under the observation of their senses. That we are all ready to believe the information which we receive from the testimony of our fellow creatures is undeniable; and indeed without such belief every man's knowledge of facts and events would be confined to those only of which he himself had been a personal witness. In that case, no man who had not travelled would believe that there are such cities as Rome and Constantinople; and no man whatever could now believe that such heroes as Hannibal and Cesar had ever existed.

Between words and things there is no natural connection; and though we are all accustomed to give to things the names by which they are known in the language that we speak, and to express their mutual relations by the words appropriated for that purpose; yet it is obviously impossible to denote one thing by the name of another, and to express by words relations that have no existence. This being the case, it may be asked upon what principle we give credit to human testimony? To this question various answers have been given, which have produced much controversy on one of the most important subjects which can employ the mind of man.

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The reason
assigned by
Hume for
this propen-
sity
* *Essay on
Miracles.*

"We may observe (says Mr Hume*), that there is no species of reasoning more common, more useful, and even necessary to human life, than that which is derived from the testimony of men and the reports of eye-witnesses and spectators. This species of reasoning perhaps one may deny to be founded on the relation of cause and effect. I shall not dispute about a word. It will be sufficient to observe, that our assurance in any argument of this kind is derived from no other principle than our observation of the veracity of human testimony, and of the usual conformity of facts to the reports of witnesses. It being a general maxim that no (A) objects have any discoverable connection together, and that all the inferences which we can draw from one to another are founded merely on our experience of their constant and regular conjunction; it is evident that we ought not to make an exception to this maxim in favour of human testimony, whose connection with any event seems in itself as little necessary as any other. Were not the memory tenacious to a certain degree; had not men commonly an inclination to truth, and a principle of probity; were

they not sensible to shame when detected in falsehood: Were not these, I say, discovered by *experience* to be qualities inherent in human nature, we should never repose the least confidence in human testimony. And as the evidence derived from witnesses and human testimony is founded on past experience, so it varies with the experience, and is regarded either as a *proof* or *probability*, according as the conjunction between any particular kind of report and any kind of object has been found to be constant or variable. There are a number of circumstances to be taken into consideration in all judgments of this kind; and the ultimate standard by which we determine all disputes that may arise concerning them, is always derived from experience and observation. The reason why we place any credit in witnesses and historians, is not derived from any *connection* which we perceive *a priori* between testimony and reality, but because we are accustomed to find a conformity between them. But when the fact attested is such a one as has seldom fallen under our observation, here is a contest of two opposite experiences; of which the one destroys the other as far as it goes, and the superior can only operate on the mind by the force which remains. The very same principle of experience which gives us a certain degree of assurance in the testimony of witnesses, gives us also, in this case, another degree of assurance against the fact which they endeavour to establish; from which contradiction there necessarily arises a counterpoise, and mutual destruction of belief and authority."

This account of the origin of faith in testimony ¹³⁷ has been controverted with much success by the Doc-^{confuted,} and tors Campbell and Reid. "That the evidence of testimony is derived solely from experience (says the former of these writers §), is at least not so incon-^{§ Dissertation on Mi-}testable a truth as Mr Hume supposes it; that, on the^{racles, and} contrary, testimony hath a natural and original influ-^{The Phi-}ence on belief antecedent to experience, will, I ima-^{losophy of}gine, easily be conceived. For this purpose, let it be^{Rhetoric.} remarked, that the earliest assent which is given to testimony by children, and which is previous to all experience, is, in fact, the most unlimited; that by a gradual experience of mankind, it is gradually contracted, and reduced to narrower bounds. To say, therefore, that our diffidence in testimony is the result of experience, is more philosophical, because more consonant to truth, than to say that our faith in testimony has this foundation. Accordingly, youth, which is unexperienced, is credulous; age, on the contrary, is distrustful. Exactly the reverse would be the case were this author's doctrine just." This is a complete confutation of the reasoning of Mr Hume; but in order to prevent all cavilling, it is to be wished that the very acute author had explained more fully what he means by saying, that testimony hath a *natural* and *original* influence on belief; for these words may be taken in different senses, in one of which what he affirms is true, and in another false.

Dr

(A) Is there then no discoverable connection between a tree and the field in which it grows; between a man and his cloaths; between an author and his work; between a sceptic and paradoxes? Surely all these are correlates, and necessarily suggest the ideas of each other.

Of Testi-
mony.§ Inquiry
into the Hu-
man Mind,
&c.

Dr Campbell's omission is amply supplied by Dr Reid, who gives § the following account of testimony, and of the credit which it obtains. "The wise and beneficent Author of nature, who intended that we should be social creatures, and that we should receive the greatest and most important part of our knowledge by the information of others, hath, for these purposes, implanted in our nature two principles that tally with each other. The first of these principles is a propensity to speak truth, and to use the signs of language so as to convey our real sentiments. This principle has a powerful operation even in the greatest liars; for where they lie once, they speak truth a hundred times. Truth is always uppermost, and is the natural issue of the mind. It requires no art or training, no inducement or temptation, but only that we yield to a natural impulse. Lying, on the contrary, is doing violence to our nature, and is never practised even by the worst men without some temptation. Speaking truth is like using our natural food, which we would do from appetite, although it answered no end; but lying is like taking physic, which is nauseous to the taste, and which no man takes but for some end which he cannot otherwise attain.—When we are influenced by any motive, we must be conscious of that influence, and capable of perceiving it upon reflection. Now, when I reflect upon my actions most attentively, I am not conscious that in speaking truth I am influenced on ordinary occasions by any motive moral or political. I find that truth is always at the door of my lips, and goes forth spontaneously if not held back. It requires neither good nor bad intention to bring it forth, but only that I be artless and undesigning. There may indeed be temptations to falsehood, which would be too strong for the natural principle of veracity, unaided by principles of honour or virtue; but where there is no such temptation, we speak truth by *instinct*. By this instinct, a real connection is formed between our words and our thoughts; and thereby the former become fit to be signs of the latter, which they could not otherwise be."

Such is the account which Dr Reid gives of the truth of human testimony: and he adds, that there is another original principle implanted in us by the Supreme Being, to tally with it, viz. a disposition to confide in the veracity of others, and to believe what they tell us. "This (he says) is the counterpart to the former; and as that may be called the *principle of veracity*, we shall, for the want of a more proper name, call this the *principle of credulity*. It is unlimited in children, until they meet with instances of deceit and falsehood; and retains a very considerable degree of strength through life."

It is ever with extreme reluctance that we controvert the opinions of this able writer; and that reluctance

cannot be lessened in the present instance, when we are conscious that great part of what he says is unanswerable. That truth is always at the door of the lips; that it requires no effort to bring it forth; that in ordinary cases men speak truth uninfluenced by any motive moral or political; that the greatest liars speak truth a hundred times where they lie once; and that lying is never practised by the worst men without some temptation, are positions which daily experience renders it impossible to question: But notwithstanding this, we do not think that truth is spoken by an *instinctive* principle; because it is inconceivable that instinct should teach the use of arbitrary and artificial signs, such as the words of every language undoubtedly are; or that between such signs and ideas any *instinctive* connection should ever be formed. "Truth (as we have defined it) is the conformity of those words or signs by which things are expressed, to the things themselves;" and things themselves are what they are, independent of us, our instincts, and perceptions. When we have precise and adequate ideas of objects, and when those ideas are related to one another as the objects themselves are related, we are in possession of mental truth; and in this case there is a *real* and *natural* connection between the signs and the things signified: for we cannot frame original and simple ideas which have no archetype in nature; nor can *one* object, distinctly perceived, generate in our minds the ideas that are generated by *other* objects. Here external things are the objects, and ideas are the signs, which, when they are in conformity to the things signified by them, constitute truth.

But in human testimony, the ideas in the mind of the speaker are the things signified, and the words of language are signs by which they are expressed; and when these things and signs are in conformity to each other, the words uttered express so much truth.—Now, though in this case there is no *natural* connection between the sign and the thing signified, yet it is obvious, that without a violent effort of the speaker to the contrary they must always be in conformity with each other; because, in every language, there are words appropriated for the purpose of denoting every idea and relation which can be expressed; and in the mind of every man these ideas, relations, and words, have been constantly associated from the time that he learned to speak. So intimate is this association, and so impossible to be broken, that whoever will pay sufficient attention to the operations of his own mind, will find that he *thinks* as well as *speaks* in some language; and that in cogitation he supposes and runs over, silently and habitually, those sounds which in speaking he actually utters (B). If this be so, it is impossible that a man without some effort should ever speak any thing but truth: for the *ideas* of what he has seen or heard, &c. are not of his manufacture;

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mony.

(B) This seems to have been *Plato's* opinion;—for he calls *thinking* λόγον ον αὐτὴ πρὸς αὐτὴν ἢ ψυχὴ διερχεται, πρὸς ἑαυτὴν σκοπῶν, "the language by which the soul explains itself to itself when it considers any thing." And *Plotinus* says, οἱ ἐν φωνῇ λόγοι μιμήματα τῶν ἐν ψυχῇ, "the vocal words are an imitation of those of the soul." To say that vocal words are an imitation of those of the soul, is to speak inaccurately, and to reverse the process of association; but it affords sufficient evidence, that in the opinion of *Plotinus* men think as well as speak in words.

nufacture; they are generated by external objects: and till they be effaced from the memory, they must always, by the law of association, make their appearance there with all their mutual relations, and in their proper drefs. In the very act of learning to speak, we necessarily learn to speak the *truth*: for were we not to employ words exactly as they are employed by those with whom we converse, our language (if language it might be called) would be unintelligible; and we could neither declare our wants nor ask relief with any hopes of success. *Children* beginning to speak, may indeed utter untruths without any motive, and merely from mistake; because the ideas and words of children have neither been long nor closely associated: but it is impossible that a *man*, however wicked, should habitually and without motives lie on ordinary occasions, unless the fundamental principles of his nature have been totally altered; unless his brain has been disordered by disease; unless his ideas have been disarranged, and all his original associations broken.

We know indeed by woful experience, that immoral men occasionally utter falsehoods with a view to deceive. But on these occasions they are influenced by some motive either of hope or terror: the falsehood is always uttered with an effort: and so strong is the association between words and ideas, that the truth will at times break out in spite of all their endeavours to suppress it; so that the end or middle of a false narrative, if it be of any length, is commonly incon-

sistent with the beginning. We entertain a suspicion concerning any matter of fact, when those who relate it contradict each other—when they are but few in number, or of doubtful character—when they have an interest in what they affirm—when they deliver their testimony with hesitation—or, on the contrary, with too violent asseverations; because these are circumstances which we have generally experienced to accompany false witness. It is likewise with reluctance that we admit a narrative of events entirely different from every thing which hitherto we have seen or heard; because we may not be certain that the narrator is not under some influence to deceive us in matters concerning which we have nothing but his testimony on which to ground our judgment. But in every case where the fact recorded is in itself possible, and attributed to an adequate cause; where a competent (c) number of witnesses had sufficient means of information, and are certainly under no inducement to deceive; testimony is complete evidence, however extraordinary the fact may be; because no fact which is known to have an adequate cause can be so incredible, as that a number of men of sound understandings should act contrary to the fundamental principles of human nature, or be able, if so disposed, to dissolve associations which had been formed in the mind of each from his infancy, and form new ones, all agreeing exactly with one another, but all contrary to truth.

PART II. OF BODY WITH ITS ADJUNCTS.

CHAP. I. *Of the COMPOSITION of BODIES; or, of MATTER and FORM.*

HITHERTO we have contemplated only the powers of our own minds by which we acquire a stock of ideas, and the various operations of the intellect upon those ideas, as treasured up in the memory or imagination. In the course of the inquiry we have found, that every idea and notion which we have was suggested by something independent of us; and in order to discover what those things are, we have investigated the nature of each sense, as it is by the senses only that we have any communication with the external world. By touch we perceive heat and cold, hardness and softness, figure, solidity, motion, and extension; by the organ of smell, we perceive odours; by the tongue and palate, tastes; by the ear, sounds; and by the sight, colours. We have likewise seen, that heat and cold, odours, tastes, sounds, and colours, are mere sensations which have no existence but while they are perceived. On the other hand, hardness and soft-

ness, figure and solidity, motion and extension, are neither sensations, nor like sensations; but are conceived to be something external and independent of us, and to be the causes of certain sensations. Even of heat and cold, odours, tastes, sounds, and colours, we know with certainty that there is some cause independent of our faculties, which may operate in a desert wilderness as well as in a populous city, though, for want of sentient beings to operate upon, it cannot in the wilderness produce the same effects as in the city.

Of things perceived by the senses we find the greater part always united; for when a man perceives a piece of sealing-wax, if he makes use of all his senses, he perceives at once cold, taste, colour, hardness, roughness or smoothness, figure, solidity, motion or rest, and extension. That the powers or qualities, which in this instance produce the sensations of heat or cold, taste, odour, and colour, are so united to the hardness, figure, solidity, and extension of the wax, as that they cannot exist alone, is evident; because it is impossible to remove any one of these things, or to conceive it removed, without removing with it all the rest.

(c) Should it be asked what number we call competent, we beg leave to say, that it will be greater or less according to circumstances. In cases where they are not liable to the deceptions of sense, two men of integrity and intelligence deserve equal credit with two thousand; but where there is particular occasion for good organs, whether of sight, hearing, or touch, the greater the number the greater is our security. To this must be added, that as one man is influenced by that which to another would be no motive, a great number of witnesses concurring in the same testimony is always an additional security that they are not under the influence of any latent bias.

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rest. What then is the bond of this union? Do these things necessarily accompany one another, so as that one of them cannot exist without bringing all the rest along with it? No; there is no necessary connection among them: for by the operation of fire the wax may be rendered liquid, when the *hardness* and *cold* are gone, tho' every thing else remains the same, or nearly the same, as it was before. By a still further operation of fire the appearance may be entirely changed; and that which was formerly a piece of hard red wax, may be reduced to smoke and ashes, in which there is neither hardness, colour, odour, nor figure; at least there is not in the smoke and ashes *such* hardness, colour, odour, or figure, as was in the wax. The solidity and extension, however, remain; for we perceive ashes and smoke to be extended and solid as much as wax or an adamant; nor is it possible to do any thing with the wax, or with any other sensible object, which shall deprive it of extension or solidity.

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Some of
these things
termed ac-
cidents, and
why.

Thus, then, extension and solidity may exist and be perceived when separated from hardness, colour, and odour; but none of these can exist, or be conceived to exist, independent of extension and solidity. Hardness, colour, odour, taste, and figure, or the things which suggest these notions to us, have with great propriety been termed accidents or qualities; because they cannot exist or be conceived to exist by themselves, but require for their support one common subject. Extension and solidity can exist independent of them, but they cannot exist independent of solidity and extension.

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Things per-
ceived by
the senses,
qualities
which in-
here in a
subject call-
ed matter.

Is then solidity the basis of these qualities, so that they necessarily result from it? No; there are many things solid and extended which are neither hard, nor coloured, nor odorous, nor sapid; which could not be if these qualities were the necessary effect of solidity. Besides, all mankind conceive of solidity and extension as qualities of something else; for we never say that solidity is extended or coloured, or hard or odorous, but that something solid has these qualities: whence it is evident that we consider solidity as a quality itself. In what then does solidity and all the other sensible qualities inhere, since they cannot exist separately, and do not support each other? This is a question which modern philosophers pretend not to answer: but some of the ancients were not so modest. Aristotle and his followers resolved every bodily substance into *matter* and *form*, making matter the basis or *substratum*, and under form comprehending all sensible qualities.

As attempts have been lately made to revive this philosophy, it may not be improper to give a short view of the doctrine of *matter* and *form*, if it were only to discover whether the speculations of Aristotle and his adherents on this subject deserve to be preferred to those of Newton and Locke.

The most perspicuous, and by far the most elegant writer among the moderns who has adopted the ancient philosophy, is Mr Harris; and lest we should be accused by others of doing injustice to a subject above

the reach of ordinary comprehension, we shall transcribe so much of what he has said of *matter* and *form* in his philosophical arrangements as seems necessary to make our readers understand his meaning as far as it is intelligible.

"Matter (says this writer) is that elementary constituent in composite substances which appertains in common to them all, without distinguishing them from one another. Every thing generated or made, whether by nature or art, is generated or made out of something else; and this something else is called its subject or matter. Such is iron to the saw; such is timber to the boat. Now this *subject* or *matter* of a thing being necessarily previous to that thing's existence, is necessarily different from it, and not the same. Thus iron, as iron, is not a saw; and timber, as timber, is not a boat. Hence, then, one character of every *subject* or *matter*, that is, the character of *negation* or *privation*. [He means *negation* or *privation* of what is to be made out of it.]

"Again, though the *subject* or *matter* of a thing be not that thing, yet, were it incapable of becoming so, it could not be called its subject or matter. Thus iron is the *subject* or *matter* of a saw; because, though not a saw, it may still become a saw. On the contrary, timber is not the subject or matter of a saw; because it not only (as timber) is no saw, but can never be made one from its very nature and properties. Hence, then, besides *privation*, another character of every *subject* or *matter*, and that is the character of *aptitude* or *capacity*. [He means aptitude or capacity to be that which is made out of it.]

"Again, when one thing is the *subject* or *matter* of many things, it implies a *privation* of them all, and a *capacity* to them all. Thus iron being the subject or matter of the saw, the axe, and the chissel, implies *privation* and *capacity* with respect to all three. Again, we can change a saw into a chissel, but not into a boat; we can change a boat into a box, but not into a saw. The reason is, there can be no change or mutation of one thing into another where the two changing beings do not participate the same matter (D). But even here, were the boat to moulder and turn to earth, and that earth by natural process to metallise and become iron; through such progression as this we might suppose even the boat to become a saw. Hence therefore it is, that all change is by immediate or mediate participation of the same matter. Having advanced thus far, we must be careful to remember, first, that every *subject* or *matter* implies, as such, *privation* and *capacity*; and next, that all change or mutation of beings into one another is by means of their participating the same common matter. This we have chosen to illustrate from works of art, as falling more easily under human cognisance and observation. It is, however, no less certain as to the productions of nature, though the superior subtlety in these renders examples more difficult. The question then is, whether in the world which we inhabit, it be not admitted from experience, as well as from the confession of all philosophers, that substances

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of
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The Peri-
patetic doc-
trine con-
cerning
matter;

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Which is
described
as destitute
of every
attribute or
quality,

(D) In a note he says: This reasoning has reference to what the ancients called *υλη προσεχης*, the immediate matter, in opposition to *υλη πρωτη*, the remote or primary matter.

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substances of every kind (E), whether natural or artificial, either immediately or mediately, pass into one another; and whether, in that case, there must not be some one *primary matter* common to all things. I say some one *primary matter*, and that common to all things, since without some *such* matter, *such* mutation would be wholly impossible. But if there be some one *primary matter*, and that common to all things, this matter must imply, not (as particular and subordinate matters do) a particular privation and a particular capacity, but, on the contrary, *universal* privation and *universal* capacity. If the notion of such a being appear strange and incomprehensible, we may farther prove the necessity of its existence from the following considerations: Either there is no such general change as here spoken of; which is contrary to fact, and would destroy the sympathy and congeniality of things: Or, if there be, there must be a matter of the character here established; because without it (as we have said) such change would be impossible. Add to this, however hard *universal* privation may appear, yet had the *primary matter*, in its proper nature, any one particular attribute, so as to prevent its *privation* from being unlimited and universal, such attribute would run through all things, and be conspicuous in all. If it were white, all things would be white; if circular, they would be circular; and so as to other attributes; which is contrary to fact. Add to this, that the opposite to such attribute could never have existence, unless it were possible for the same thing to be at once and in the same instance both white and black, circular and rectilinear, &c. since this inseparable attribute would necessarily be every where; because the matter, which implies it, is itself every where, at least may be found in all things that are generated and perishable.

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And to be
apprehended
only by
abstraction
and analogy.

“Here then we have an idea (such as it is) of that singular being *ὡς ἡ πρώτη*, the *primary matter*; a being which those philosophers who are immersed in sensible objects know not well how to admit, though they cannot well do without it; a being which flies the perception of every sense, and which is at best, even to the intellect, but a negative object, no otherwise comprehensible than either by analogy or abstraction. We gain a glimpse of it by abstraction, when we say that the *first matter* is not the lineaments and complexion which make the beautiful face; nor yet the flesh and blood which make those lineaments and that complexion; nor yet the liquid and solid aliments which make that flesh and blood; nor yet the simple bodies of earth and water which make those various aliments; but something, which being below all these, and supporting them all, is yet different from them all, and essential to their existence. We obtain a sight of it by analogy, when we say, that as is the brass to the statue, the marble to

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the pillar, the timber to the ship, or any one *secondary matter* to any one *peculiar form*; so is the *first* and *original matter* to all forms in general.”

Such is the doctrine of the Peripatetics concerning the *primary matter*, or the basis of bodily substances. We forbear to make any remarks upon it till we have seen what they say of *form*, the other essential part of every body; for what is meant by *matter* and *form* will be most completely seen when they are viewed together.

“FORM (says the same elegant writer) is that elementary constituent in every composite substance, by which it is distinguished, and characterised, and known, from every other. But to be more explicit: The *first* and most simple of all extensions is a line: this, when it exists, united with a second extension, makes a superficies; and these two, existing together with a third, make a solid. Now this last and complete EXTENSION we call the *first* and *simplest* FORM; and when this *first* and *simplest* form accedes to the *first* and *simplest* matter, the union of the two produces body; which is for that reason defined to be *matter triply extended*. And thus we behold the rise of pure and original body (F). It must be remembered, however, that body, under this character, is something indefinite and vague, and scarcely to be made an object of scientific contemplation. It is necessary to this end that its extension should be bounded; for as yet we have treated it without such regard. Now, the bound or limit of simple body is figure; and thus it is that figure, with regard to body, becomes the next form after extension.

“But though the boundary of body by figure is one step towards rendering it definite and knowable, yet is not this sufficient for the purposes of nature. It is necessary here, that not only its external should be duly bounded, but that a suitable regard should likewise be had to its internal. This internal adjustment, disposition, or arrangement (denominate it as you please), is called ORGANIZATION, and may be considered as the third form which appertains to body. By its accession we behold the rise of BODY PHYSICAL OR NATURAL; for every such body is some way or other organized. And thus may we affirm, that these three, that is to say, extension, figure, and organization, are the three original forms to body physical or natural; figure having respect to its external, organization to its internal, and extension being common both to one and to the other. It is more than probable, that from the variation in these universal and (as I may say) primary forms, arise most of those secondary forms usually called qualities sensible, because they are the proper objects of our several sensations. Such are roughness and smoothness, hardness and softness; the tribes of colours, flavours, odours; not to mention those powers of character more subtle, the powers electric, magnetic (G), medicinal, &c.

2

“Here

(E) He must mean only bodily substances; for it is not admitted by such philosophers as make a distinction between mind and body, that the one ever passes into the other.

(F) “Original body (he says), when we look downward, has reference to the *primary matter*, its substratum: when we look upwards, it becomes itself a matter to other things; to the elements, as commonly called, air, earth, water, &c. and in consequence to all the variety of natural productions.”

(G) That it is from the extension, figure, and organization of bodies, that their medicinal powers arise, seems to be undeniable; for medicines operate by contact: but it is not so clear that the same forms, to use the author’s language, are the source of magnetical powers. If the magnet be surrounded with an atmosphere extending to a certain distance, such may be the case; but if not, the author’s conjecture must be ill founded. See MAGNETISM.

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"Here therefore we may answer the question, how *natural bodies are distinguished*. Not a single one among them consists of *materials in chaos*, but of materials wrought up after the most exquisite manner, and that conspicuous in their *organisation*, or in their *figure*, or in *both*.—As therefore every *natural body* is distinguished by the *differences* just described, and as these *differences* have nothing to do with the *original matter*, which being every where similar can afford no distinction at all; may we not here infer the expediency of *ESSENTIAL FORMS*, that every *natural substance* may be essentially *characterised*? These *forms*, though they differ from matter, can yet *never subsist without it*; but *united* with it, they help to produce every *composite* being, that is to say, in other words, every *natural substance*, in the visible world. It must be remembered, however, that it is the *FORM* in this union which is the *source of all distinction*. It is by *this* that the *ox* is distinguished from the *horse*, not by that *grain* on which they subsist, the *common matter* to both. To which also may be added, that as figures and sensible qualities are the *only objects of our sensations*, and these are all *parts of natural form*; so therefore (contrary to the sentiment of the vulgar, who dream of nothing but of matter) *it is form, which is in truth the whole that we either hear, see, or feel*; nor is mere matter any thing better than an *obscure imperfect being*, knowable only to the *reasoning faculty* by the two methods already explained, I mean that of *analogy* and that of *abstraction*. Here therefore we conclude with respect to *sensible forms*, that is to say, *forms immersed in matter and ever inseparable from it*. In these and matter we place the *ELEMENTS OF NATURAL SUBSTANCE*."

If this extract appear long, let it be remembered that it contains the fullest and most perspicuous detail which is to be found in the English language, of a doctrine of which the author of *Ancient Metaphysics* supposes Locke to have been ignorant; and for which ignorance he affects to treat the English philosopher

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with supercilious contempt. Had Locke really been ignorant of the ancient doctrine of *matter and form*, it is probable that most people will be of opinion that the *contempt* expressed by his censurer might have been spared; but if it should appear, that, as far as this theory is intelligible, it differs not, except in words, from the doctrine laid down in the *Essay concerning human understanding*, what shall we think of that zeal for ancient phrases, which had influence sufficient to make one respectable philosopher pour contempt upon another who was an ornament to his country?

What Mr Harris has said of *matter and form* respecting works of art, is sufficiently intelligible, and extremely just. Nor should we object to the account which he gives of the origin of natural body, if he had not divested his first matter of every power and every quality, solidity and extension not excepted. But though we can suppose body divested of any one particular figure and of every sensible quality, such as colour, odour, tastes, &c. and the *substratum* or *basis* or *matter* of it still to remain, yet it seems impossible to conceive it divested of *solidity* without supposing it totally annihilated. Nay, if we have any just notion at all of solidity, it is evidently inseparable from the substratum of body, whatever that substratum be; and indeed, though Mr Harris divests his first matter of every attribute, the argument by which he proves the necessary existence of such a being does not require its privation to be so universal. "Had the *primary matter* (says he), in its proper nature, any one particular attribute, so as to prevent its privation from being unlimited and universal, *such attribute would run through all things* and be conspicuous in all." This indeed is obvious and undeniable: but *solidity* and *extension* do in *fact* run through *all things* into which the *substratum* or *matter* of body is ever formed or ever can be conceived to be formed; and therefore there is no necessity for supposing the first matter divested of these attributes (H).

Mr Harris says, that both Timæus and Plato drop

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Matter cannot be destitute of solidity.

(H) Nor does it appear that it was divested of them by all the ancient philosophers. We learn from Cudworth, that "the atomical physiology, the most ancient perhaps of any, teaches that body is nothing else but *διαστροφή* *αυλίσκος*, *extended bulk*; and that nothing is to be attributed to it but what is included in the nature and idea of it, viz. greater or less magnitude with divisibility into parts, figure, and position, together with motion or rest, but so as that no part of body can ever move itself. And consequently, this philosophy supposes, that there is no need of any thing else besides the simple elements of magnitude, figure, site, and motion (which are all clearly intelligible, or different modes of extended substance), to solve the corporeal phenomena by; and therefore not of any substantial *forms* distinct from the matter; nor of any other qualities really existing in the bodies without, besides the results or aggregates of those simple elements, and the disposition of the insensible parts of bodies in respect of figure, site, and motion; nor of any intentional *species* or *shows* propagated from the objects to our senses; nor, lastly, of any other kind of motion or action really distinct from local motion (such as generation and alteration), they being neither intelligible as modes of extended substance, nor any way necessary: Forasmuch as the forms and qualities of bodies may well be conceived to be nothing but the result of those simple elements of magnitude, figure, site, and motion, variously compounded together; in the same manner as syllables and words in great variety result from the different combinations and conjunctions of a few letters, or the simple elements of speech; and the corporeal part of sensation, and particularly that of vision, may be solved only by local motion of bodies; that is, either by corporeal effluvia (called *simulacra*, *membranae*, and *exuviae*), streaming continually from the surface of the objects, or rather, as the later and more refined atomists conceived, by pressure made from the object to the eye, by means of light in the medium. So that *ὡς διαβαλὴν τῶν ταυτῶν αἶρος το βλεπόμενον ἀναγκάζεται*, the sense taking cognizance of the object by the subtle interposed medium, that is tense and stretched (thrusting every way from it upon the optic nerves), doth by that, as it were by a staff, touch it. Again, generation and corruption may be sufficiently explained by concretion and secretion, or local motion, without substantial forms and qualities

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expressions as if they considered *matter* to be *place*; but *place*, as will be seen afterwards, can be the basis of nothing. He likewise quotes a passage from Ammonius on the predicaments, in which it is said "that there never was in *actuality* either matter without body, or body without quality;" and we appeal to our readers if it be not absolutely impossible to contemplate such a being even in *idea*. To the question, Whether the first matter has a separate existence by itself, distinct from all the qualities of body, the author of *Ancient Metaphysics* answers thus:—"We have no idea of it existing separately, because we find no such thing in nature, from which we draw all our ideas; but whether there may not be such a thing existing in the regions of infinite space, as *matter* without *form* and *dimensions*, is what I think no man can take upon him to decide." But with all submission, if a man cannot decide this question with the utmost certainty, his three ponderous volumes are nothing better than useless paper: for the subject of them is things *existing*; and concerning existence we know nothing with greater certainty, than that a being of which nothing positive can be affirmed, cannot possibly have any existence.

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Some first
matter com-
mon to all
bodies.

That, in the world which we inhabit, bodily substances of every kind, whether natural or artificial, either immediately or mediately pass into one another, is a truth which cannot be denied; and therefore it follows, that there must be some one primary matter common to all things. In modern philosophy this primary matter is considered as solid, and as the *substra-*

tum of all bodies; and all those things which, in the language of Mr Harris, are comprehended under the appellation of *form*, are called *qualities*: so that on this subject the ancient and modern philosophy differ in nothing but in the latter using the word *qualities* instead of the word *form*; and defining the first matter to be a "*solid substance every where the same*," whilst the ancient philosophy considers it as void of solidity.

Of the nature of this first matter all philosophers are equally ignorant: for, as Mr Harris says, it is in truth *form*; or, as modern philosophers would say, they are in truth *qualities*, which are the whole that we either hear, or see, or feel, or of which we have either idea or conception. Mr Locke says expressly, "That if any one will examine himself concerning his notion of pure substance in general, he will find that he has no other idea of it at all, but only a supposition of he knows not what support of such qualities as are capable of producing simple ideas in us."

But how, it has been asked, do we know that the things which we perceive are qualities, and cannot exist without a subject? We answer, Because every one of them, except solidity, may be changed or destroyed, and the subject in which they inhere still remain. Thus, though wax may be melted or burnt, and be no longer a hard red substance of such a figure and such a smell, the matter which supported the hardness, figure, colour, and smell, still remains; for melted wax or ashes is as much a solid substance as is that which may be used for the sealing of letters, &c.

It has been said that solidity (1) is the *substratum* of

qualities. And lastly, those sensible ideas of light and colours, heat and cold, sweet and bitter, as they are distinct things from the figure, site, and motion of the insensible parts of bodies, seem plainly to be nothing else but our own fancies, passions, and sensations, however they be vulgarly mistaken for qualities in the bodies without us." *Cudworth's Intellectual System*, Book i. chap. i.

This, as will be seen by and by, is the philosophy of Newton, Locke, and all their followers: and that it is the genuine philosophy of the ancient atomists, we may safely take the word of the author whom we have quoted; for no modern has been more conversant with their writings, more completely master of their language, or has given their sense with greater accuracy. Those authors, therefore, who in their zeal for ancient metaphysics would explode the physiology of Newton and Locke, and substitute in its place the Aristotelian doctrine of *matter* and *form*, belie their own pretences; for the theory which they would banish is more ancient than that which they wish to introduce; and we appeal to our readers if it be not more intelligible.

(1) The philosophers of most eminence who have maintained this opinion are, *Dr Watts*; the author of the *Procedure, Extent, and Limits, of the Human Understanding*; and *Dr Law* late bishop of Carlisle, who in a note upon *King's origin of evil* gives the opinion of the triumvirate in the following words:—"We find by experience, that a thing will always exhibit the same appearances in some respects, though it admit of changes in others: or, in Mr Locke's language, that certain numbers of simple ideas go constantly together, whereas some others do not. The former of these we call the *substance*, thing, or being, itself; the latter are termed its modes or *accidents*. Thus the substance of *body*, as far as we know of it, consists in solidity and extension; which being necessarily finite, it also becomes capable of division, figure, and motion. These are its original inseparable qualities, which constitute the thing, and seem not to depend on any thing else as a *subject*. But a particular figure, motion, &c. are only accidents or modes of its existence; which do not necessarily attend it, though they themselves cannot be supposed to exist without it. The substance of *spirit* consists in the powers of thinking and acting, which likewise admit of various modifications. This seems to be all that we can learn concerning the nature of things from observation and experience. To inquire into the *manner* how these, which we call *properties*, exist together, or to attempt to explain the *cause*, ground, or reason, of their union, is in vain. To assign the word *substance* for a representation of it, is saying nothing: it is setting a mere word for what we have neither any idea of nor occasion for. Indeed if we consider these primary qualities as needing something to inhere in, we are obliged to seek for something to support them: and by the same way of reasoning, we may seek for something else to support that other something, and so on; and at last shall find no other support for the whole but the cause which produced it." "*Dr Watts* (continues the bishop) is of opinion, that it is introducing a needless *scholastic* notion into the real nature of things, and then fancying it to have a real existence;" (*Logic*, p. 14.) The author of the *Procedure, Extent, &c.* affirms, "That as far as we directly know the essential properties of any substance, so far we have a *direct* knowledge of the substance

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of body; and men have been probably led into this notion from a conviction that such *substratum*, whatever it be, is and must be solid; but that solidity is only a quality inseparable from the first matter, and not that matter itself, must be evident from this consideration, that solidity is the same in all bodies, and incapable of producing by itself any other effect than that of excluding from the place occupied by it every other solid substance. It could not of itself be the *substratum* of colour, taste, or smell, otherwise all bodies would be coloured, sapid, and odorous; and as, according to all our notions of it, it is incapable of any change, it could not by itself be so modified as to excite in us these sensations.

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ers of Man.

The things then immediately perceived by us, or of which we have any adequate idea or conception, are only qualities which must belong to a subject; and all that we know about this subject is, that it is that to which such qualities belong. From this it is evident, that our notion of matter, as distinguished from its qualities, is a relative and obscure notion, and must remain obscure till men have other faculties. In this the philosopher seems to have no advantage above the vulgar: for as they perceive colour, and figure, and motion, by their senses, as well as he does; and as both are equally certain that there is a subject of those qualities; so the notions which both have of this subject are equally obscure; or, to speak more properly, they have no *positive* notion of it all. When a philosopher calls it the *first matter*, a *substratum* or a *subject* of *inhesion*, those learned words convey no meaning but what every man understands and expresses, by saying in common language, that it is a thing extended, solid, and moveable.

They are therefore *qualities*, or in the language of ancient philosophy, *forms* alone, about which, in corporeal substance, we can reason with precision and certainty; and it is sufficient for all the purposes of life that we have of them an adequate knowledge. For as the *first matter* or original *substratum* of all bodies seems to be the same, though we know not what it is; and as one body is distinguished from another only by its *qualities* or *powers*; a knowledge of the nature of these is all that can be necessary to direct our conduct with respect to the various objects with which we are surrounded.

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Qualities,
primary
and

Qualities thus considered in bodies, are, first, such as are utterly inseparable from the body, in what state soever it is; such as in all the changes and alterations which it suffers, and under all the force which can be employed upon it, it constantly keeps. Thus, in the instance already given, a stick of sealing-wax may, by the operation of fire, be rendered liquid or reduced to smoke and ashes; and when it has undergone these changes, it has lost many of the sensible qualities which it had when a long round substance fit for the purpose

of sealing letters; but other qualities which were then perceivable in it still remain: for not only liquid wax, but every particle of smoke and ashes, is solid and extended, as well as the hardest or largest body; and every such particle has likewise some figure, and is capable of motion or rest. Again, if a grain of wheat or any other corporeal substance be divided into two parts, and each part be again divided without end, still the smallest particle of it will be solid, extended, of some figure, and capable of further division. *Solidity*, *extension*, *divisibility*, and *motion* or *rest*, are therefore qualities inseparable from *body*, and have on that account been with great propriety called its *original* or *primary qualities*.

There are other qualities, which in truth are nothing in the bodies themselves, but powers arising from the magnitude, figure, texture, and motion, of their insensible parts, to produce in us various sensations; such are *colours*, *sounds*, *tastes*, and *odours*. These have been denominated *secondary qualities*; and to them may be added a third sort, which are universally allowed to be barely *powers*, though they are in fact as much real qualities in the subject as those we have just mentioned. Thus the power in fire to produce by its primary qualities a new colour or consistency in wax or clay, is as much a quality in the fire as the power which it has to produce in us a new sensation of warmth or burning. That *colours*, *tastes*, *sounds*, and *odours*, as they are perceived by us, are mere sensations, has been already proved: and that the powers in the bodies which produce these sensations are not, like *solidity* and *extension*, inseparable from the body to which they may belong, is evident; because a piece of *red* wax may be reduced to *black* ashes; and because by pounding an almond we may change its clear white colour into a dirty hue, and its pleasant taste into one that is oily and rancid; and a single rent through the body of a bell destroys its sound.

The primary qualities of body have a real existence, independent of us and of every other creature. Thus the particular *bulk*, *number*, *figure*, and *motion*, of the *parts* of *fire* or *snow* are *really* in the *fire* or *snow*, whether any man's senses perceive them or not; and therefore these may be called *real qualities*, because they really exist in the bodies: But *light*, *heat*, *whiteness*, or *cold* (as they are perceived by us), are no more *really* in *fire* or *snow*, than *sickness* is in *tartar* or *pain* in a *sword*. Take away the sensations of them: let not the eyes see light or colours, nor the ears hear sounds; let not the palate taste nor the nose smell; and all colours, tastes, odours, and sounds, as they are such particular sensations, vanish and cease, and are reduced to their causes, *i. e.* to the bulk, figure, and motion of the parts of the body.

The qualities then that are in bodies, rightly con-

sidered, are of three sorts. 1. The *bulk*, *figure*, *number*,

2. *situation*, three sorts.

substance itself: and if we had a direct knowledge of all the essential properties of any substance, we should have an *adequate* knowledge of that substance; for surely, if there be any meaning in words, the knowing any thing of the essential properties of a thing is knowing *so much* of its very substance.

That the substance of body consists in *solidity* and *extension*, and nothing more; and that these depend not upon any thing else as a *subject*; cannot be true: for *solidity*, in our conception, is nothing but *impenetrability*; but whoever uses the word *impenetrability*, certainly means that there is *something* impenetrable. That there is some real thing or being different from *solidity* and *extension*, which impresses us with the notion that it is solid and extended, is self-evident to all mankind: if it be not matter, these conceptions must be communi-

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situation, and motion or rest, of their solid parts. Of these, as they are in themselves, we have clear and distinct notions. We know that they are in the body whether we perceive them or not, and we call them *primary* or *essential* qualities. 2. The power that is in any body, by reason of its internal texture and insensible primary qualities, to operate upon our senses in a peculiar manner, producing in us the different sensations of colours, sounds, tastes, or smells, &c. These we have called *secondary* qualities, but they are often termed *sensible* qualities. 3. The power that is in any body, by reason of the particular constitution of its primary qualities, to make such a change in the bulk, figure, texture, and motion of another body, as to make it operate on our senses differently from what it did before. Thus, the sun has a power to make wax white, and fire to make lead fluid. These are universally called *powers*; but we have no such notions of them as we have of the *primary* qualities of bodies. We know that they exist, but we know not what they are. It has indeed been discovered, that the sensation of smell is occasioned by the effluvia of bodies†; that of sound, by their vibration. The disposition of bodies to reflect a particular kind of light occasions the sensation of colour; and the operation of the minute parts of bodies upon the nerves of the tongue and palate is the cause of tastes. Very curious discoveries have been made of the nature of heat and its manner of operating, and an ample field still remains. We are likewise intuitively certain, that body can operate upon body only by impulse; but how certain impulses upon certain organs should produce sensations in us to which there is nothing similar in the impelling body, is equally unknown to the clown and the philosopher.

† Reid's
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say, &c.

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specting
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* Lib. de
Sensu et Sen-
sibili, cap. 4.

Such is the distinction which in modern philosophy is made between primary and secondary qualities; but it is a distinction which was likewise well known to that sect of ancient philosophers who were denominated *atomists*. At the head of these were Thales and Pythagoras (κ); and we may infer from Aristotle, that the sect comprehended almost all the physiologists who taught before himself and Plato: for he says*, Δημοκρίτος και οι πλείστοι των φυσιολογων αποπατατον τι ποιουσι, παντα γαρ τα αισθητα απλα ποιουσι, και εις σχηματα αναγουσι τους χυμους: "Democritus, and most of the *physiologists*, fall into a great absurdity; for they make all sense to be touch,

and resolve sensible qualities into the figures of insensible atoms." And he adds, that "the former physiologists (without exception) said not well, that there is no black and white without the sight, nor bitter and sweet without the taste." He elsewhere § tells us, that those philosophers explained generation and alteration without forms and qualities, by figures and local motion." Δημοκρίτος και Λευκιππος ποιησαντες τα σχηματα την αλλοιωσιν και την γενεσιν εκ τουτων ποιουσι, διακρισει μιν και συγκρισει γενεσιν και φθοραν, ταξις δε και δισσει αλλοιωσιν. "Democritus and Leucippus having made figures (or variously figured atoms) the first principles, make generation and alteration out of these; namely, generation together with corruption from the concretion and secretion of them, but alteration from the change of their order and position." By the atomic physiologists the name of *quality* was generally applied only to those things which we have called *secondary* qualities. The *primary* being considered as *essential* to matter, were seldom, if ever, called *qualities*. That the atoms, which they held to be the first principles of bodies, were figured, solid, extended, and moveable, is apparent, not only from the short view of their system which we have given from Cudworth, but likewise from the passages which we have just quoted from Aristotle: but the question debated between them and their antagonists was, whether those atoms had *smell*, *taste*, and *colour*; or, as it was commonly expressed, whether they had *qualities*? Democritus, Leucippus, and the other atomists, we see, maintained that they had not; and the following account of the doctrine of Protagoras, another philosopher of that school, shows, that on this subject at least the ancient advocates for the atomic system reasoned as justly as any of the moderns, and much more justly than the Peripatetics and Platonists by whom they were opposed. Plato having in his Theætetus first said in general that the philosophy of Protagoras made all things to consist of a commixture of atoms and local motion, represents his doctrine concerning colours in particular, after this manner: "First, as to that which belongs to the sight, you must conceive what is called a white or black colour, not to be any thing absolutely existing either without your eyes or within your eyes; but black and white, and every other colour, is caused by different motions made upon the eye, from objects differently modified; so that it is nothing either in the agent or patient absolutely,

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cated to us by the immediate agency of the Deity, which seems to have been the real opinion of the Bishop of Carlisle. But this differs not from the theory of Berkeley, which we shall consider by and by.

(κ) This is denied by Bishop Warburton, who thinks nothing better settled than that Democritus and Leucippus were the authors of the atomic physiology. We highly respect the learning and ingenuity displayed in the Divine Legation of Moses; but on this point we are convinced that its author is mistaken. Strabo expressly affirms, that Moëhus the Phenician was the author of the atomic physiology; and Cudworth has proved, by arguments which to us are perfectly satisfactory, that Thales and Pythagoras were both atomists, and that they derived the doctrine from Phœnicia or Egypt. They did not, indeed, speculate in physics, but delivered their doctrines as they had received them from tradition, and they referred all motion to mind as its cause. Leucippus and Democritus, we believe, were the first speculative atomists: but though they refined upon, and perhaps improved, the mere mechanical part of the physiology of their masters, they unhappily dropt the better part of it; and, banishing mind from their system of the universe, they became materialists and atheists. With the sober and pious part of philosophers this brought the atomic theory into disrepute; and Plato and Aristotle, who were theists, when they opposed that theory, always pointed their arguments against Leucippus and Democritus, which is probably what led the learned bishop to consider these atheists as the authors of the atomic physiology.

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folutely, but something which arises from between them both (L).” From this passage it is plain that Protagoras thought of colours exactly as Mr Locke thought, that they are not *real qualities* existing in bodies, but merely sensations excited in our minds; and indeed he is presently after represented as having called them *τινα ἐν ἡμῖν φασματά*, *certain fancies or appearances in us*. But there is in the Theætetus another passage, in which a fuller account is given of the atomic philosophy, to this purpose: “The principle upon which all these things depend is this, That the whole universe (M) is motion of atoms and nothing else; which motion is considered two ways, and is accordingly called by two names, *action* and *passion*. From the mutual congress, and, as it were, attrition of these together, are begotten innumerable offsprings, which, though infinite in number, yet may be reduced to two general heads, *sensibles* and *sensations*, which are both generated at the same time. The *sensations* are *seeing*, *hearing*, and the like; and the corresponding *sensibles* are *colours*, *sounds*, &c. Wherefore, when the eye and its proper object meet together, both the *αἰσθητόν* and the *αἰσθησις*, the *sensible idea* of white and black, and the *sensation* of seeing, are generated together, neither of which would have been produced if those two had not met. The like is to be conceived of all other *sensibles*, as hot and cold, &c. None of these are absolute things in themselves, or real qualities in external objects; but they are begotten from the mutual congress of agent and patient, and that by motion. So that neither the agent has any such thing in it before its congress with the patient, nor the patient before its congress with the agent. But the agent and patient meeting together, and begetting *sensation* and *sensibles*, both the object and the sentient are forthwith made to be so and so qualified; as when honey is tasted, the sensation of tasting, and the quality of sweetness, are begotten together, though the sensation be vulgarly attributed to the taster, and the quality of sweetness to the honey.” The conclusion of all which is summed up thus, *οὐδὲν εἶναι αὐτὸ καὶ αὐτὸ, ἀλλὰ τινι αἰεὶ γιγνέσθαι*: “Not one of these sensible things is any thing absolutely in the object without, but they are all generated or made relative to the sentient (N).”

The language of ancient philosophy was defective in precision; terms were used vaguely and improperly, so that the meaning of the author is often to be collected only from the context. When Protagoras is here made to say, that when the agent and patient meet together, both the object and the sentient are forthwith made to be so and so qualified; as when honey is tasted, the sensation of tasting and the quality of sweetness are begotten together; it could not be his meaning, that any real change is made upon the

external object merely by our tasting it, but only that the actual sensation and the sensible *idea* of sweetness are produced at once; just as he had said before, that the sensible idea of white or black, and the sensation of seeing, are generated together. If his words be thus interpreted, they express a noble truth; and the whole passage shows, that the ancient Atomic theory differed not from the theory of Des Cartes, Newton, and Locke, being the most rational as well as the earliest system of physics with which we have any acquaintance. By divesting body of *essential forms* distinct from matter and motion, and by giving to the first matter extension and solidity, it renders the corporeal world intelligible; and accounts for those appearances which are called secondary qualities, in a manner perfectly satisfactory. Aristotle indeed opposed the Atomic philosophy, and had influence enough to bring it into disrepute for many ages; but when he insisted that the two constituent principles of body are *matter* and *form*, both independent of all sentient beings, and which may be conceived as existing distinct from each other, he substituted for a simple and sublime theory an absurd and incomprehensible fiction.

CHAP. II. Of the ESSENCES of BODIES.

HAVING treated of the substance, qualities, and powers of body, we may seem to have exhausted this part of our subject; but there is still more to be done. Metaphysicians, ancient and modern, have introduced another term into the science, to denote that which distinguishes one species or sort of bodies from all other species or sorts; and this term we shall briefly explain. Gold is apparently different from lead, and from every other species of metal; a horse is apparently different from an ox, and from every other species of animals; and all animals apparently differ from all vegetables, as vegetables differ from metals.

It is only with the *bodies*, not the minds of animals, that we are at present concerned; and we have seen that all bodies are composed of the same matter.—What then is it that makes different bodies exhibit to us such different appearances; or, in other words, how come they to be possessed of such different qualities and powers? It is (say the followers of Plato and Aristotle) from their having different *essential forms*, by which every natural substance is essentially characterised; for of every animal, vegetable, or metal, &c. there is a *form* conceived, as existing before the individuals in which it is incorporated, from which result all the properties of that animal, vegetable, or metal, such as *figure*, *size*, *colour*, and the other qualities.

(L) Ὑπολαβεῖ τοῖνυν οὕτως κατὰ τὰ ὀμματα πρῶτον, ὃ δὲ καλεῖται χρομα λευκὸν μὴ εἶναι οὐλο εἶρον τι ἐξω τῶν σῶν ὀμματιῶν, μὴδ ἐν τοῖς ὀμμασι, ἀλλὰ μελάν τι καὶ λευκὸν καὶ ὅτιον αλλο χρομα ἐκ τῆς προσβολῆς τῶν ὀμματιῶν πρὸς τὴν προσήκουσαν φορὰν φανείναι γιγνέμενον καὶ οὐδὲν ἐκαστὸν εἶναι φανέν χρομα, οὐτε το προσβαλλόν οὐτε το προσβαλλόμενον ἀλλὰ μετὰ τὴν ἐκαστῶν ἰδίων γέγονος.

(M) Protagoras was a follower of Leucippus and Democritus in every thing, and of course an atheist.—This, however, does not hinder him from having been a correct physiologist with respect to the composition of body; and as such only is he quoted by us. It is, indeed, melancholy to think, that there was hardly a sect of ancient philosophers in which there were not many atheists.

(N) Ἀρχὴ δὲ ἐξ, ἥς αὖ νυν δὴ ἐλεγομένη πάντα ἡρτῆται ἢ δὲ αὐτῶν, ὡς το παν κινήσεις ἢν καὶ αλλο παρὰ τοῦτο οὐδὲν, τῆς δὲ κινήσεως δύναμις, πληθεῖ μὲν ἀπειρον ἑκάτερον, δύναμιν δὲ το μὲν ποιεῖν ἔχον, το δὲ παθεῖν, &c.—See the Theætetus; see also Cudworth's Intellectual System, Book I. chap. i.

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Bodies.

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According
to the Peri-
patetics and
Platonists,
from essen-
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ties perceptible by our senses: but this *internal and essential form* itself, from which all other forms result, is not perceptible by our senses, nor even by our understanding directly and immediately, nor otherwise than by the analogy formerly mentioned. These essential forms, we are told, mean something, which, though different from matter, can yet never subsist without it; something which, united with it, helps to produce every *composite* being, that is to say, in other words, every natural substance in the visible world.

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But these
forms have
no exist-
ence.

This assertion Mr Harris submits with deference to his contemporaries; because (says he) "I speak perhaps of spectres as shocking to some philosophers as those were to Æneas which he met in his way to hell—*Terribiles visu formæ*." The elegant author's unwillingness to frighten his contemporaries, was a proof of his amiable and benevolent disposition; but he needed not to have suffered from any such apprehension. Those spectres, apparently so dreadful, had long before been laid to rest by the incomparable Cudworth, who has demonstrated, that *essential forms* different from matter and motion, as they have no real existence, had no place in the most ancient philosophy; and that the different appearances or sensible qualities which different bodies exhibit, are the result of the different contexture of their insensible parts. Thus, gold and lead are composed of the same primary matter, but the atoms or minute parts of that matter are in the one substance differently combined from what they are in the other; and this different combination is the sole cause that gold is specifically heavier than lead, more ductile, and of a different colour, &c. For the very same reason, iron is harder than either gold or lead, specifically lighter, and possessed of many other sensible qualities which are not found in either of these substances. One vegetable differs from another externally in size, colour, taste, smell, rapidity of growth, and proportion of parts, &c. but all vegetables are composed of the same matter; and the external difference which prevails among them is the result of a different structure and motion of their insensible parts. The same is to be said of the differences which prevail among the bodies of animals; they all result from internal organization and motion, and from nothing else, whatever be the immediate cause of that motion.

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This particular internal texture and motion of insensible parts, is that which makes one sort of bodies differ externally from every other sort of bodies; and it is by modern metaphysicians called the *real essence* of bodies. Thus, that internal texture of minute parts, which makes gold of a bright yellow, extremely ductile, specifically heavier than all other metals, and soluble in *aqua regia*, is the real essence of gold; but what that essence is in itself no man can tell, as we perceive only the qualities which result from it. We are, however, certain, that it is different from the real essences of lead and iron, because it produces different effects from those which are produced by these essences; and different effects are never produced in the same circumstances by the same cause.

We have called the internal texture and motion of the insensible parts of bodies their *real essences*, to di-

stinguish them from other *essences* which are only *nominal*, and with which we are perfectly acquainted, because they are the fabrication of our own minds.—Thus, a beautiful bright yellow, a certain specific gravity, extreme ductility, and solubility in *aqua regia*, are the qualities by which we distinguish gold from all other metals. Of these qualities we frame a sort of general conception, which we call the *essence* of gold; and every substance in which we find this essence, we class under the specific name gold. For though it is obvious that our conceptions cannot be the *real essences* of things external, yet are they sufficient guides to these essences, as we know that bodies which, being all formed of the same matter, have the very same sensible qualities, must likewise have the same internal organization or texture of parts, because it is only in that organization or texture that one body can differ from another.—And so much for bodily substance, qualities, and essences.

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Nominal ef-
fences, what
they are.

CHAP. III. Of the EXISTENCE of MATTER.

WE have endeavoured to prove, that all corporeal substances consist of minute atoms, solid and extended; and that the sensible qualities of every body result from the combination and motion of the atoms of which that body is composed. The celebrated Berkeley, Bishop of Cloyne, however, attempted to demonstrate that these atoms have no real existence; and that the very supposition of a solid, extended, and inert substance, being the archetype of our ideas, involves in it an absurdity and contradiction.

It is universally allowed, that all our knowledge of matter is derived through the senses, either immediately in the very act of sensation, or mediately by an association which is resolvable into a process of reasoning. According to the principles which we have stated, and laboured to establish, matter itself is no immediate object of the senses; and as these are the principles upon which the Bishop erected his demonstration, it will be incumbent upon us to consider his theory, because it has been represented as in the highest degree pernicious, and as leading to universal scepticism.

The author of the *Essay on the Nature and Immortality of Truth*, represents Berkeley as teaching us, "that external objects (that is, the things which we take for external objects) are nothing but ideas in our minds; in other words, that they are in every respect different from what they appear to be; that matter exists not but in our minds; and that independent on us and our faculties, the earth, the sun, and the starry heavens, have no existence at all; that a lighted candle hath not one of those qualities which it appears to have; that it is not white, nor luminous, nor round, nor divisible, nor extended; but that, for any thing we know, or can ever know to the contrary, it may be an Egyptian pyramid, the king of Prussia, a mad dog, the island of Madagascar, Saturn's ring, one of the Pleiades, or nothing at all." With respect to the consequences of this theory, he affirms, that "it is subversive of man's most important interests, as a moral, intelligent, and percipient being; and not only so, but also, that if it were universally and seriously adopted,

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ed, the dissolution of society, and the destruction of mankind, would necessarily ensue within the compass of a month."

The dissolution of society and the destruction of mankind are indeed dismal consequences—enough to make a man shudder in his closet. But do they really flow from Berkeley's system? They certainly do, if it be the aim of that system to prove that a candle has not any one quality which it appears to have, and that it may be a *mad dog*; for should all philosophers, by some means or other, become converts to the theory of Berkeley, as we know that the bishops Sherlock, Smalridge, and others, actually did, the dissolution of society and the destruction of mankind would indeed be inevitable. The scribbling race, by using mad dogs for candles, would all become infected with the hydrophobia; and having their natural irritability augmented by the canine rabies, they would bite and tear till not a human being were left alive.

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A view of
his theory
given by
himself.

But to drop this ludicrous style, so unsuitable to philosophical investigation and calm inquiry, we beg leave to affirm, that the theory of Berkeley is here totally and grossly misrepresented, and that not one of those dangerous consequences which flow from that misrepresentation can be fairly deduced from any thing taught in *The Principles of Human Knowledge* and the *Dialogues on the Existence of Matter*. So far is Berkeley from teaching that external things are nothing but ideas in our minds, and that they are in every respect different from what they appear to be, that he teaches the very reverse of this in the plainest language possible. "I am of a vulgar cast (says he), simple enough to believe my senses, and leave things as I find them. It is my opinion, that the real things are those very things I see and feel and perceive by my senses. That a thing should really be perceived by my senses, and at the same time not really exist, is to me a plain contradiction. When I deny sensible things an existence out of the mind, I do not mean *my* mind in particular, but *all* minds. Now it is plain they have an existence exterior to my mind, since I find them by experience to be independent of it. There is therefore some other mind wherein they exist during the intervals between the times of my perceiving them; as likewise they did before my birth, and would do after my annihilation. And as the same is true with regard to all other finite created spirits, it necessarily follows there is an *omnipotent eternal mind*, which knows and comprehends all things, and exhibits them to our view in such a manner, and according to such rules, as he himself hath ordained, and are by us termed the laws of nature."

So far is Berkeley from teaching that, independent on us and our faculties, the earth, the sun, and the starry heavens, have no existence at all, and that a lighted candle has not one of those qualities which it appears to have, that he over and over affirms the direct contrary; that the universe has a real existence in the mind of that infinite God in whom, according to the scriptures, we all live, and move, and have our being; that a lighted candle has not only all those qualities which it appears to have, but that, with respect to us, it has nothing else; that so far from being continually deceived by our senses, we are never deceived by them; and that all our mistakes concerning mat-

ter are the result of false inferences from true sensations.

The Bishop makes the same distinction that we have made between ideas and notions; restraining the use of the former term to denote the relicts of sensation, and employing the latter to denote our knowledge or conception of spirits and all such objects as are not perceived by sense. He likewise affirms, that we can have no *idea* of an external inert substance; because an idea can be like nothing but another idea, or the sensation of which it is a relict: and as all mankind admit that ideas and sensations can have no existence but in the mind of a percipient being, he therefore infers that we can have no *idea* of any thing existing unperceived, and by consequence can have no idea of matter in the philosophical sense of that word. Solidity, extension, divisibility, motion, figure, colour, taste, and all those things which are usually called qualities primary and secondary, being according to him mere ideas, can have no existence but in a mind perceiving them; but so far is he from supposing their existence to depend upon the perception of our minds, that he says expressly, "When in broad day-light I open my eyes, it is not in my power to choose whether I shall see or no, or to determine what particular objects shall present themselves to my view; and so likewise as to the hearing and other senses, the ideas imprinted on them are not creatures of my will. There is therefore some other will or spirit that produces them. The question between the materialists and me is not, Whether things have a real existence out of the mind of *this* or *that* person? but, Whether they have an absolute existence, distinct from being perceived by *God*, and exterior to *all* minds? I assert, as well as they, that since we are affected from without, we must allow powers to be without in a being distinct from ourselves. So far we are agreed. But then we differ as to the kind of this powerful being. I will have it to be spirit; they matter, or I know not what third nature. Thus I prove it to be spirit: From the effects I see produced, I conclude there are actions; and because actions, volitions (for I have no notion of any action distinct from volition); and because there are volitions, there must be a will. Again, the things I perceive must have an existence, they or their archetypes, out of my mind: but being ideas, neither they nor their archetypes can exist otherwise than in an understanding: there is therefore an understanding. But will and understanding constitute in the strictest sense a mind or spirit. The powerful cause, therefore, of my ideas is, in strict propriety of speech, a spirit."

This is a faithful abstract of Berkeley's theory given in his own words. Matter, according to him, cannot be the *pattern* or *archetype* of ideas, because an idea can resemble nothing but another idea, or the sensation of which it is a relict. Matter, he thinks, cannot be the *cause* of ideas; for every cause must be active, and matter is defined to be inert and incapable of action. He therefore infers, that all our sensations of what we call the qualities of body are the effect of the immediate agency of the Deity upon our minds; and that corporeal substance has no existence, or at least that we have no evidence of its existence. That such may *possibly* be the origin of our sensations, no

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man will deny who reflects upon the infinite power and wisdom of the Agent from whom they are said to proceed. Dr Reid himself, the ablest of all Dr Berkeley's opponents, frankly acknowledges that no man "can show, by any good argument, that all our sensations might not have been as they are, though no body or quality of body had ever existed."

In its consequences we do not perceive that this theory can be hurtful either to religion, to virtue, or to the business of common life; for it only explodes the notion of a substratum, which, though it may have a real existence, was never thought of by the generality of mankind in any nation under heaven. Dr Beattie indeed affirms, that in "less than a month after the nonexistence of matter should be universally admitted, he is certain there could not, without a miracle, be one human creature alive on the face of the earth." But this assertion must be the consequence of his mistaking Berkeley's nonexistence of matter for the nonexistence of sensible objects, the reality and existence of which the Bishop never denied. On the contrary, he expressly says, "We are sure that we really see, hear, feel; in a word, that we are affected with sensible impressions; and how are we concerned any farther? I *see* this cherry, I *feel* it, I *taste* it; and I am sure *nothing* cannot be seen, or felt, or tasted: it is therefore *real*. Take away the sensations of softness, moisture, redness, tartness, and you take away the cherry." All this is equally true and equally conceivable, whether the combined sensations which indicate to us the existence of the cherry be the effect of the immediate agency of God or of the impulse of matter upon our minds; and to the lives of men there is no greater danger in adopting the former than the latter opinion.

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But it has been said, that Berkeley's doctrine necessarily leads to scepticism in religion, as the same kind of reasoning which he employs to prove the non-existence of matter, operates equally against the existence of mind, and consequently against the possibility of a future state of rewards and punishments. "The rational issue of this system (we are told) is scepticism with regard to every thing excepting the existence of our ideas and their necessary relations. For ideas being the only objects of thought, and having no existence but when we are conscious of them, it necessarily follows, that there is no object of our thought which can have a continued and permanent existence. Body and spirit, cause and effect, time and space, to which we were wont to ascribe an existence independent of our thought, all are turned out of existence by this short dilemma: Either those things are ideas of sensation or reflection, or they are not: If they are ideas of sensation or reflection, they can have no existence, but when we are conscious of them: If they are not ideas of sensation or reflection, they are words without any meaning."

This sophism was advanced as a consequence from Berkeley's principles by Mr Hume; and upon these principles it has been deemed unanswerable by subsequent philosophers of great merit. But is it really a part of Berkeley's system, or can it be fairly inferred from the principles on which that system is built? These questions it is fit that Berkeley should answer for himself: and we shall venture to assert, that his

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answer will be perfectly satisfactory to every reader who attends to the distinction, which, after the Bishop, we have stated between ideas and notions.

Though we believe this dangerous inference from Berkeley's principles is commonly attributed to Hume as its author, it did not escape the sagacity of the Bishop himself. In the third dialogue, *Hylas*, who pleads for the existence of matter, thus objects to the reasoning of his antagonist. "Notwithstanding all you have said, to me it seems, that according to your own way of thinking, and in consequence of your own principles, it should follow, that you are only a system of floating ideas, without any substance to support them. Words are not to be used without a meaning. And as there is no more meaning in spiritual substance than in material substance, the one is to be exploded as well as the other."

To this *Philonous* answers: "How often must I repeat, that I know or am *conscious* of my own being; and that I myself am not my ideas, but somewhat else; a thinking active principle, that perceives, knows, wills, and operates about ideas? I know that I, one and the same self, perceive both colours and sounds; that a colour cannot perceive a sound, nor a sound a colour; that I am therefore one independent principle, distinct from colour and sound; and, for the same reason, from all other sensible things and inert ideas. But I am not in like manner *conscious* either of the existence or essence of matter. Farther, I know what I mean, when I affirm that there is a spiritual substance or support of ideas; *i. e.* that a spirit knows and perceives ideas. But I do not know what is meant, when it is said that an unperceiving substance hath inherent in it, and supports, either ideas or the archetypes of ideas. In the very notion or definition of material substance there is included a manifest repugnance and inconsistency. But this cannot be said of the notion of spirit. That ideas should exist in what doth not perceive, or be produced by what doth not act, is repugnant. But it is no repugnance to say, that a perceiving thing should be the subject of ideas, or an active being the cause of them. That I, who am a spirit or thinking substance, exist, I know as certainly as I know that my ideas exist. I know likewise what I mean by the terms *I* and *myself*; and I know this immediately or intuitively; though I do not perceive it as I perceive a triangle, a colour, or a sound. Ideas are things inactive and perceived; and spirits a sort of beings altogether different from them, by which they are perceived. I do not, therefore, say, that my soul is an idea, or like an idea. However, taking the word *idea* in a large sense, my soul may be said to furnish me with an idea, that is, an image or likeness of God, though indeed extremely inadequate. For all the notion I have of God is obtained by reflecting on my own soul, heightening its powers, and removing its imperfections. I have, therefore, though not an inactive idea, yet in myself some sort of an active thinking image of the Deity. And though I perceive him not by sense, yet I have a notion of him, or know him, by reflection and reasoning. My own mind and my own ideas I have an immediate knowledge of; and by the help of these do immediately apprehend the *possibility* of the existence of other spirits and ideas. Farther,

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from my being, and from the dependency I find in myself and my ideas, I do by an act of reason necessarily infer the existence of a God, and of all created things in the mind of God. It is granted that we have neither an immediate evidence, nor a demonstrative knowledge, of the existence of *other finite spirits*; but it will not therefore follow, that such spirits are on a footing with material substances: if, to suppose the one be inconsistent, and if it be not inconsistent to suppose the other; if the one can be inferred by no argument, and there is a probability of the other; if we see signs and effects indicating distinct finite agents like ourselves, and see no sign or symptom whatever that leads to a rational belief of matter. I say, lastly, that I have a *notion* of spirit, though I have not, strictly speaking, an *idea* of it. I do not perceive it as an idea, or by means of an idea; but know it by reflection. Whereas, I neither perceive matter objectively as I do an idea, nor know it as I do myself by a reflex act; neither do I mediately apprehend it by similitude of the one or the other, nor yet collect it by reasoning from that which I know immediately. All which makes the case of matter widely different from that of the Deity and all spirits."

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Not satisfied with this, he endeavours to prove the existence of matter impossible.

Thus far we think Berkeley's theory tenible, and its consequences harmless. That by the immediate agency of the Deity all our sensations *might* be what they are though matter had no existence, we think he has proved by arguments unanswerable; and we are likewise of opinion, that by admitting the evidence of sense, consciousness, and reason, in their fullest extent, and by distinguishing properly between those things of which we have *ideas*, and those of which we have *notions*, he has sufficiently secured the existence of spirits or percipient beings, and obviated the irreligious sophistry of Hume before it was conceived by that author. But the good Bishop stops not here. Not satisfied with proving that all our sensations lead us immediately to the Deity, and that, for aught we know, matter, as defined by philosophers, may have no separate existence, he proceeds farther, and endeavours to prove that matter cannot possibly exist. This appears even in the extracts which we have quoted from his book, in which he talks of the repugnance and inconsistency of the notion. In this part of his system, we think he errs greatly, and advances an opinion altogether inconsistent with his own just principles.

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His reasoning

The repugnance of which he speaks, arises solely from considering solidity and extension as relicts of sensation, or ideas of the same kind with those of heat and cold, tastes and sounds. "Light, and colours, heat and cold, extension and figures; in a word, the things we see and feel; what are they (says his Lordship), but so many sensations, notions, ideas, or impressions, on sense? and is it possible to separate even in thought any of these from perception? Some there are who make a distinction betwixt *primary* and *secondary* qualities: by the former, they mean extension, figure, motion, rest, solidity or impenetrability, and number: by the latter, they denote all other sensible qualities, as colours, sounds, tastes, and so forth.—The ideas we have of these they acknowledge not to be the resemblances of any thing existing without the

mind, or unperceived; but they will have our ideas of the primary qualities to be patterns or images of things which exist without the mind, in an unthinking substance which they call *matter*. But it is evident that extension, figure, and motion, are only ideas existing in the mind; that without extension solidity cannot be conceived; that an idea can be like nothing but another idea; and that consequently neither they nor their archetypes can exist in an unperceiving substance. Hence it is plain, that the very notion of what is called *matter* or *corporeal substance*, involves a contradiction in it."

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This account of extension and solidity affords a striking instance how much the most vigorous and upright mind is liable to be warped by prejudice in behalf of a darling theory, and how apt the clearest understanding is to be blinded by the equivocal use of terms. That Bishop Berkeley possessed a vigorous and perspicacious mind, his most vehement antagonists are eager to admit; and that his intentions were good, is known to all Europe. Yet by the equivocal use of the word *idea*, which the writings of Locke had then introduced into the language of philosophy, he has here suffered himself to lose sight of a very proper and accurate distinction, which, so far as we know, was among the moderns first made by himself between *ideas* and *notions*. According to the Bishop, "we have a *notion* of power and a *notion* of spirits, but we can have no *idea* either of the one or the other; for all ideas being passive and inert, they cannot represent unto us by way of image or likeness that which acts. Such is the nature of *spirit* or that which acts, that it cannot be of itself perceived, but only by the effects which it produceth. It must be owned, however, that we have some *notion* of soul, spirit, and the operations of the mind, such as willing, loving, hating, inasmuch as we know or understand the meaning of these words."

Now we beg leave to affirm, that what is here said of spirits, and of which we readily admit the truth, is equally true of material or solid substances. We have no *ideas* of solidity and extension, because these things are not originally impressed upon the senses; but we have very distinct though relative *notions* of them, for they are clearly perceived by the effects which they produce. That this is at least possible, we have the acknowledgment of Bishop Berkeley himself: for he "freely owns, that from a cause, effect, operation, sign, or other circumstance, there may reasonably be inferred the existence of a thing not immediately perceived; and that it were absurd for any man to argue against the existence of that thing, from his having no direct and positive notion of it." This is exactly the case with respect to solid substances. These substances we do not immediately perceive; but we infer their existence from effects, signs, and other circumstances, and we have of them very clear though relative notions. Thus a man can open and shut his empty hand; but when he grasps an ivory ball of three or four inches diameter, he feels, that though the same power be exerted, his hand cannot then be shut. He is conscious that there is no change in himself; and being intuitively certain that every effect must have a cause, he infers with the utmost confidence, that the cause which prevents his hand from shutting is in the ball; or, in other words,

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that the thing which communicates to his eye the sensation of colour, and impresses upon his hand a sensation of touch, must be solid or impenetrable. Solidity, however, is not the sensation itself; it is only the cause of the sensation; and therefore it is so far from being an idea in our minds, that we are conscious our notion of it is of a thing totally different from all our ideas, of a thing external, at least to our minds. Indeed the notion itself is not positive; it is only relative, and inferred from the effects which are produced on our senses. That it is the *same* thing which communicates to our eye the sensation of colour, and has the power of resisting the compression of our hand, is evident; because, when the ball is thrown away, the resistance as well as the actual sensation vanish at once.

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From this fact, which a less acute man would think a proof that the resistance was not occasioned by the immediate agency of the Supreme Being, but by the impenetrability of a solid substance of small dimensions, the Bishop argues thus against the *possibility* of such a substance: "They who assert that figure, motion, and the rest of the primary or original qualities, do exist without the mind in unthinking substances, do at the same time acknowledge, that colours, sounds, heat, cold, and such like secondary qualities, do not; which they tell us are sensations existing in the mind alone, that depend on and are occasioned by the different size, texture, and motion, of the minute particles of matter. This they take for an undoubted truth, which they can demonstrate beyond all exception. Now if it be certain, that those original qualities are inseparably united with the other sensible qualities, and not even in thought capable of being abstracted from them, it plainly follows, that they exist only in the mind. But I desire any one to reflect and try whether he can by any abstraction of thought conceive the extension and motion of a body, without all other sensible qualities. For my own part, I see evidently that it is not in my power to frame an idea of a body extended and moved, but I must withal give it some colour or other sensible quality, which is acknowledged to exist only in the mind. In short, extension, figure, and motion, abstracted from all qualities, are inconceivable. Where, therefore, the other sensible qualities are, there must be these also, to wit, in the mind, and no where else."

In this reasoning, though plausible, there is an unintended fallacy. It is indeed true, that we cannot contemplate in imagination a solid substance without conceiving it to have some colour; but there is sufficient reason to believe, that this union of colour and solidity in our minds is not the effect of nature as it operates at first upon our senses, but merely the consequence of early and deep-rooted association. Bishop Berkeley himself has taught us, that the objects of sight are not at a distance; and that if a man born blind were suddenly made to see, he would conceive the objects of his sight as existing either in his eye or in his mind. This is a truth which no man will controvert who has dived into the science of optics, or who has even paid the slightest attention to the perceptions of infants; and if so, it follows, that to a man born blind and suddenly made to see, colour and solidity would

not appear united. Were such a person to lay hold of an ivory ball and raise it to the elevation of his eye, he would perceive whiteness as a new sensation existing in his eye or his mind, but he would feel resistance at the extremity of his arm. He would not have the least reason to conclude, that this whiteness was inseparably united to the cause of this resistance; and he would, in fact, draw no such conclusion, till experience had taught him, that by removing the ball or cause of resistance from his hand, he at the same time removed the sensation from his eye. After repeated experiments, he would indeed discover, that the cause of colour to the eye, was likewise by some means or other the cause of resistance to the hand; and he would so associate these in his mind, that the one would never afterwards make its appearance as an idea or a notion without bringing the other along with it. The whole difficulty, therefore, in this case, is to break an early and deep-rooted association; for it is plain that the associated ideas were not originally united, and that solidity and colour were at first conceived as separate.

If the reader perceive not the force of this reasoning, we beg leave to recommend to him the following experiment, which, if we mistake not, will carry conviction to his judgment, that in the last quoted passage Bishop Berkeley has argued fallaciously, and that extension and colour are not *inseparably* united as ideas in the mind. Let him go into a dark room, containing a number of spherical bodies of various colours; let him take one of them into his hand; and he will instantly *feel* resistance, and have a *notion* of extension and solidity; but will he likewise have the *idea* of colour inseparably united with this notion? The Bishop says he will: and if so, it must be the idea of some *particular* colour; for his Lordship has taught us, that the *abstract* and *general* idea of colour, which is neither *red*, nor *green*, nor *blue*, &c. cannot possibly be formed. The man, then, we shall suppose, whilst he feels resistance, conceives the resisting body to be *green*; and holding it still in his hand, walks into the light of day. The *resistance*, and consequently the *cause* of resistance, remains unchanged; but what becomes of the inseparable union of those with colour, when the body, upon being actually seen, proves to be *black*, i. e. to have no colour at all?—It appears, therefore, undeniable, that solidity and colour are not united in nature; that the one is an essential quality of something external to us, of which we have no *idea*, but a very distinct though relative *notion*; and that the other is an actual sensation in our minds, caused by the impression of something external on the organ of sense, which leaves behind it in the memory or imagination a positive and direct *idea* that exists no where else.

Solid substance, therefore *may* exist, for though it is not immediately perceived by the senses, and is a thing of which we can have no *idea*, we acquire a clear and distinct *notion* of it, by the very same means which Bishop Berkeley thinks sufficient to give us distinct notions of power and of spirits; and, therefore, that notion can involve in it no contraction. Still, however, we would not say with Dr Beattie, "that we could as easily believe, that two and two are equal to ten;"

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ten; or, that whatever is, is not; as that matter has no separate existence:" for it is certainly *possible*, that the Supreme Being, without the instrumentality of matter, could communicate to our minds all the sensations and notions from which we infer the reality of solid substance. All that we contend for, as having the evidence of demonstration, is the *possibility* of solid and extended substance; and if the thing be *possible*, the general voice of mankind proclaims its *probability*.—We are *conscious* of our actual sensations, and we know by *experience* that they are caused by something distinct from ourselves. When a man grasps an ivory ball, he *feels* that he cannot shut his hand, and he knows that the resistance which prevents him proceeds *not* from *himself*. Thus far all mankind are agreed. But Bishop Berkeley says, that the resistance proceeds immediately from the Supreme Being or some other spirit; whilst we, without pretending that his scheme is impossible, think it more natural to suppose that the man's hand is kept from shutting by the resistance of a solid substance of four inches diameter; of which substance, though we have no *idea* of it, we have as distinct a *notion* as Berkeley had of spirits. From one or other of these causes this effect must proceed; and it is of little importance to life or happiness which of them be the true cause, since it is with the effect only that we are immediately concerned. Still, however, a philosopher would choose to adopt the easiest and most natural side of every alternative; which, if our notion of solidity be just, is certainly, in the present case, the existence of matter.

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After treating so largely of the composition of bodies, and showing the general agreement of metaphysicians ancient and modern with respect to the notion of their solidity, it will appear strange to the less philosophical part of our readers, that we should now express a doubt of that notion's being well-founded.—We have ourselves no doubt, but on the contrary are fully convinced, that solidity is essential to matter. This, however, has of late been denied by philosophers of great merit. Dr Priestley, after Mr Mitchell and Father Boscovich, affirms that matter is *not solid* or impenetrable to other matter; and that it has, in fact, no properties but those of *attraction* and *repulsion* †. The proofs of this position, which appears so paradoxical, he draws from optical experiments, from electricity, and from the effects of heat and cold upon substances usually conceived to be solid.

† *Disquisitions on Matter and Spirit, and Correspondence with Dr Price.*

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The arguments used in support of this hypothesis

The appearances from which the solidity of matter is inferred, are nothing more, he says, than superficial appearances, and therefore have led to superficial and false judgments, which the *real appearances* will not authorise. "*Resistance*, on which alone our opinion concerning the solidity or impenetrability of matter is founded, is never occasioned by *solid matter*, but by something of a very different nature, viz. a *power of repulsion*, always acting at a real, and in general an assignable distance, from what we call the body itself. When I press my hand against the table, I naturally imagine that the obstacle to its going through the table, is the *solid matter* of which it consists; but a variety of philosophical considerations demonstrate that it generally requires a much greater power of pressure than I can exert to bring my fingers into actual contact with

the table. Electrical appearances show that a considerable weight is requisite to bring into seeming contact even the links of a chain hanging freely in the air, they being kept asunder by a repulsive power belonging to a very small surface, so that they do not actually touch, though they are supported by each other. It has been shown, from optical considerations, that a drop of water rolls upon a cabbage leaf without ever coming into actual contact with it; and indeed all the phenomena of *light* are most remarkably unfavourable to the hypothesis of the solidity or impenetrability of matter. When light is reflected back from a body on which it seems to strike, it was natural to suppose that this was occasioned by its impinging against the *solid parts* of the body; but it has been demonstrated by Sir Isaac Newton, that the rays of light are always reflected by a *power of repulsion* acting at some distance from the body. Again, when part of a beam of light has overcome this power of repulsion, and has entered any transparent substance, it goes on in a right line, provided the medium be of a uniform density, without the least interruption, and without a single particle being reflected, till it comes to the opposite side, having met with no solid particles in its way, not even in the densest transparent substances, as glais, crystal, or diamond; and when it is arrived at the opposite side, it is solely affected by the laws of attraction and repulsion.

"Nay, that the component particles of the hardest bodies themselves do not actually touch one another, is demonstrable from their being brought nearer together by cold, and by their being removed farther from each other by heat. The power sufficient to overcome these internal forces of repulsion, by which the ultimate particles of bodies are prevented from coming into actual contact, is what no person can pretend to compute. The power requisite to break their cohesion, or to remove them from the sphere of each other's attraction, may in some measure be estimated; but this affords no *data* for ascertaining the force that would be necessary to bring them into actual contact, which may exceed the other almost infinitely."

From these facts, Dr Priestley infers, that the mutual resistance of bodies proceeds in all cases from powers of repulsion acting at a distance from each body: that the supposition of the *solidity* or *impenetrability* of matter is destitute of all support whatever; and that matter itself is nothing but powers of attraction and repulsion, and several spheres of them, one within another. As other philosophers have said, "Take away solidity, and matter vanishes;" so he says expressly, "Take away attraction and repulsion, and matter vanishes."

To illustrate this strange notion, "Suppose (says he) that the Divine Being, when he created matter, only fixed certain *centres of various attractions and repulsions*, extending indefinitely in all directions, the whole effect of them to be upon each other; these centres approaching to, or receding from each other, and consequently carrying their peculiar spheres of attraction and repulsion along with them, according to certain definite circumstances. It cannot be denied that these spheres may be diversified infinitely, so as to correspond to all the kinds of bodies that we are acquainted with, or that are possible. For all effects in which

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bodies are concerned, and of which we can be sensible by our eyes, touch, &c. may be resolved into attraction or repulsion. A compages of these centres, placed within the spheres of each other's attraction, will constitute a body that we term *compact*; and two of these bodies will, on their approach, meet with a repulsion or resistance sufficient to prevent one of them from occupying the place of the other, without a much greater force than we are capable of employing; so that to us they will appear perfectly hard.

"As, in the constitution of all actual bodies that we are acquainted with, these centres are placed so near to each other, that in every division that we can make we still leave parts which contain many of these centres; we, reasoning by analogy, suppose that every particle of matter is infinitely divisible; and the *space* it occupies is certainly so. But, strictly speaking, as those centres which constitute any body are not absolutely infinite, it must be naturally possible to come by division to one single centre, which could not be said to be divisible, or even to occupy any portion of space, though its sphere of action should extend ever so far; and had only *one* such centre of attraction, &c. existed, its existence could not have been known, because there would have been nothing on which its action could have been exerted; and there being no *effect*, there could not have been any ground for supposing a *cause*."

* Free Discussion between Dr Price and Dr Priestley.

In answer to this reasoning against the solidity of matter, Dr Priestley was frequently asked by his candid and masterly antagonist *, "What it is that attracts and repels, and that is attracted and repelled?" But to the question he was never able to give a satisfactory answer. Indeed, how could he have been able? for, as Dr Price argues, "Exclusive of attraction and repulsion, he affirms matter to be absolutely nothing; and therefore, though we were to allow it the power of attracting and repelling, yet as it is nothing but this power, it must be the power of nothing, and the very idea of it be a contradiction."

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to an intuitive
and necessary
truths.

If there be any class of truths intuitively certain, that class comprehends the two following propositions: POWER CANNOT BE WITHOUT A SUBJECT; and NOTHING CAN ACT WHERE IT IS NOT. If, therefore, there be powers of attraction and repulsion, (which shall be considered afterwards in the Chapter of MOTION), there must be a subject of those powers; and if matter, whether solid or unsolid, be the subject, it cannot possibly attract or repel at a *distance*. Sir Isaac Newton, in his letters to Dr Bentley, calls the notion that matter possesses an innate power of attraction, or that it can act upon matter at a distance, and attract and repel by its own agency, "an absurdity into which, he thought, no one could possibly fall." Hence it follows, that the appearances from which Dr Priestley infers the penetrability of matter must be fallacious appearances, since they contradict an intuitive and necessary truth. The facts which he instances are, indeed, such as would make most other men suspicious of fallacy, and in his reasonings from them he sometimes takes for granted the truth to be proved. The links of a chain used for electrical purposes, supposing them to be in contact with each other, can touch only with very small surfaces. The electrical fluid is of considerable density, and incapable of being absorbed

within a very narrow compass. This is evident, because it passes not through paper and other porous bodies without making a passage for itself, and leaving a visible aperture behind it; and though it assimilates with metals, and passes through them more easily than through other bodies, yet is it plain that it requires a certain quantity of metal to conduct it; for when the conductor falls short of the necessary quantity, it is melted or dissipated by the force of the fluid. This being the case, it follows that the links of a chain *may be* in actual contact (we do not positively affirm that they *are*), and yet the fluid become visible in passing from link to link; for if the point of contact be too small to absorb the *whole* fluid, *part* of it must pass without any metallic conductor through the atmosphere, and thus become apparent to the eye of the spectator.

With respect to light, it is obvious that there cannot possibly be any *demonstration*, in the logical sense of the word, that it is reflected by a power of repulsion acting at some distance from the body; for, in the opinion of all mankind, the primary and solid atoms of matter are too minute to fall under the cognisance of our senses, however assisted by art; and therefore, if light *appears* to be reflected at a distance from the surface of the body, we must conclude, either that between the point of reflection and the apparent surface of the body, there are solid atoms unperceived by us, or that light is reflected by the agency of some other substance than matter. One of these conclusions, we say, *must* be drawn, because they are both *possible*, and there is no other alternative but to admit one of them, or to suppose that a thing may act where it is not; which is as clearly absurd and *impossible* as that *whatever is, is not*. Again, when part of a beam of light has entered any transparent substance, how does Dr Priestley know that it goes on in a right line, without the least interruption, till it comes to the opposite side? This he can know only by his senses; but the beam may meet with ten thousand interruptions from objects which the senses cannot perceive, and may describe a zig-zag line, of which the deflections are so small as to elude the keenest eye aided by the most powerful glass.

That the component particles of the hardest bodies do not *all* actually touch one another, is indeed evident from the effects of cold and heat upon those bodies: but it does not therefore follow that those bodies have no component particles; but only, that they are fewer in number than we are apt to imagine; that all the solid matter in the universe might possibly be compressed within a very narrow sphere; and that it is held together in different bodies and different systems by a power foreign from itself. These are truths which all philosophers have admitted who have thought sufficiently on the subject; but who will admit Dr Priestley's proposition, when it is translated into common English: "That the component *nothings* of the hardest bodies do not actually touch one another, is demonstrable from their being brought nearer together by cold, and by their being removed farther from each other by heat?"

Dr Priestley owns, that if matter be solid it could act upon other matter by impulse. We are certain, that, whatever it be, it can act upon nothing in the manner

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manner which he describes; and therefore, to use the words of Dr Price, "matter, if it be any thing at all, must consist of solid particles or atoms occupying a certain portion of space, and therefore *extended*, but at the same time *simple* and *uncompounded*, and incapable of being resolved into any other smaller particles. It must likewise be the different form of these *primary* particles, and their different combinations and arrangement, that constitute the different bodies and kinds of matter in the universe." This is exactly agreeable to the doctrines of Newton; who, after considering the question in every point of view, concludes, that "in the beginning God formed matter in solid, massy, hard, impenetrable, moveable particles, of such sizes and figures, and with such other properties, as most conduced to the end for which he formed them; and that those primary particles being solid, are incomparably harder than any porous bodies compounded of them; even so very hard as never to wear or break in pieces: no ordinary power being able to divide what God himself made one in the creation." To talk, as Dr Priestley does, of matter's being certain *centres of various attractions and repulsions* extending indefinitely in all directions, and to describe these centres as *not* being *physical points* or *solid atoms*, is either to say, that *nothing* attracts and repels; or it is to introduce the divine agency as the immediate cause of all our sensations. The former of these alternatives Dr Priestley disclaims; the latter he seems willing to admit. But if it be his meaning that all our sensations are caused by the immediate agency of God or created spirits, his scheme differs not from that of Berkeley, except in being less elegantly expressed and less ingeniously supported. Berkeley's scheme is evidently *possible*. The commonly received scheme is likewise *possible*. It remains therefore with the reader, whether he will adopt the system of the Bishop of Cloyne; or admit, with all other philosophers, that matter exists; that it consists of parts actually distinct and separable; and that each of these parts is a *monad* or solid atom, which requires no foreign agency to keep it united.

CHAP. IV. Of SPACE and its MODES.

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The necessary adjuncts of body, what.

HAVING considered bodies in their substance, essences, and qualities, and proved that they have a real existence independent of us and our conceptions, we proceed now to inquire into the nature of *space*, *motion*, *number*, and *duration*. These are commonly called the *adjuncts* of body, and are supposed to be absolutely inseparable from its existence. It does not indeed appear that *actual motion* is a necessary adjunct of body, considered as a mere solid, extended, and figured substance; but it is certainly necessary to the existence of organized and animated bodies; and the capability of being moved enters into our conceptions of all bodies whatever. Of these adjuncts, that which first demands our attention is *space*; for without a knowledge of its nature we could not have an adequate idea of motion, and without motion we could have no idea of time.

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Our notion of space, how acquired.

Every body is extended; and between two bodies not in actual contact, we perceive that a third body may be easily introduced. That which admits of the introduction of the third body is what we call *space*:

and if it be totally void of matter, it is called *pure space*. Whether there be any space absolutely pure, has been disputed; but that such space is possible, admits of no dispute. Were any one body (a cannon ball for instance) to be annihilated, and the circumambient air, with every other material substance, kept from rushing into the space which the ball had occupied, that portion of space, with respect to matter, would be empty or pure space: whether it would necessarily be filled with mind shall be considered afterwards. Pure space, therefore, is conceivable; and it is conceived as having three dimensions, length, breadth, and depth, which are generally called the three simple modes of space. In this respect it agrees with body: but the agreement proceeds no farther; for space is conceived as destitute of solidity, without which the existence of body is inconceivable. It has been formerly observed, that whatever may be distinctly conceived may possibly exist; but with respect to the existence of pure space, whatever is possible is real: for it shall be shown in the next section, that were there no space absolutely pure or void of matter, there could be no motion. Our business at present is to inquire what the nature of space is, and what notion we ought to have of its existence.

Many modern philosophers consider space as something entirely distinct both from body and mind: some of them ascribe to it no less than four of the attributes of the Deity—*eternity*, *immobility*, *infinity*, and *necessity* of existence; and a few of them have gone so far as to call *infinite space* the *sensorium* of the Deity. "The supposal of the existence of *any thing whatever* (says Dr Clarke *) necessarily includes a *presupposition* of the existence of *space*. Nothing can possibly be conceived to exist without thereby presupposing space; which, therefore, I apprehend to be a *property* or *mode* of the self-existent Substance; and that, by being evidently necessary itself, it proves, that the substance of which it is a property must be also necessary." Elsewhere he says, that "space is a property or mode of the self-existent Substance, but not of any other substances. All other substances are *in* space, and are *penetrated* by it; but the self-existent Substance is not in space, nor penetrated by it, but is itself (if I may so speak) the *substratum* of space, the *ground* of the existence of *space* itself." He acknowledges, however, that such expressions as "the self-existent Substance is the *substratum* of space, or space is a property of the self-existent Substance, are *not*, perhaps, very proper: but what I mean (says he), is this: The idea of *space* (as also of *time* or *duration*) is an abstract or partial idea; an idea of a certain *quality* or *relation*, which we evidently see to be necessarily existing; and yet (which not being itself a *substance*) at the same time necessarily *presupposes* a substance, without which it could not exist."

These opinions respecting space have been adopted by succeeding philosophers of great merit, and particularly by Dr Price; who says, that "it is a maxim which cannot be disputed, that *time* and *place* are necessary to the existence of all things. Dr Clarke (continues he) has made use of this maxim, to prove that infinite space and duration are the essential properties of the Deity; and I think he was right."

Had authority any weight in philosophy, we know not what modern writers we could oppose to the celebrated

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Space supposed to be something different from body and mind, and to be eternal and infinite, &c.
* Demonstration of the Being and Attributes of God, and Correspondence with a Gentleman in Gloucestershire, passim.

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This suppo-
sition con-
troverted.

brated names of Clarke and Price, unless it were Bishop Berkeley, Dr Law late bishop of Carlisle, and the author of Ancient Metaphysics. But the question is not to be decided by authority. Learned and acute as Dr Clarke was, his assertions respecting space are contradictory and inconsistent. If nothing can possibly be conceived to exist without thereby presupposing the existence of *space*, how can space be a property or mode of the self-existent Substance? Are properties prior in the order of nature, or even in our conceptions, to the substances in which they inhere? Can we frame an abstract idea of figure, or extension, or solidity, before we conceive the existence of any one figured, extended, or solid substance? These are questions which every man is as capable of answering as the Doctors Clarke and Price, provided he can look attentively into his own mind, and trace his ideas to their source in sensation: and if he be not biassed by the weight of great names, we are persuaded he will find, that if it be indeed true, that the supposal of the existence of any thing whatever necessarily includes a *presupposition* of the existence of space, *space* cannot possibly be a *property* or *mode* of the self-existent substance, but must of necessity be a *substance* itself.

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Space neces-
sary to the
existence of
every thing.

It is, however, *not* true, that the supposal of the existence of any thing whatever necessarily includes a *presupposition* of the existence of space. The idea of space is indeed so closely associated with every visible and most tangible objects, that we cannot see the one nor feel the other without conceiving them to occupy so much of space. But had we never possessed the senses of sight and touch, we could not have supposed the existence of space necessary to the existence of any thing whatever. The senses of smelling, tasting, and hearing, together with our internal powers of consciousness and intellect, would certainly have compelled us to believe in our own existence, and to suppose the existence of other things; but no object either of consciousness, smelling, tasting, or hearing, can be conceived as occupying space. Space and every thing which fills it are conceived as of three dimensions; but who ever supposed or can suppose an *odour*, *taste*, or *sound*, to have *length*, *breadth*, and *depth*; or an object of consciousness to be an ell or an inch long?

Let us suppose that body and all the visible world had a beginning, and that once nothing existed but that Being which is alone of necessary as well as eternal existence; *space*, say the followers of Dr Clarke, would then exist likewise without bounds or limits. But we desire to know of these gentlemen what sort of a being this space is. It certainly is not *substance*; neither is it a property; for we have seen that the very notions of it, which lead men to suppose its existence necessary, render it impossible to be a property of the self-existent Being. Is it then nothing? It "is in one sense": it is nothing *actually* existing; but it is something *potentially*; for it has the *capacity* of receiving body whenever it shall exist. It is not, and cannot, become any thing itself, nor hath it any actual existence; but it is that without which nothing corporeal could exist." For this reason it was that Democritus and Epicurus made space one of the principles of nature; and for the same reason Aristotle has made *privation* one of his three principles of natural things, *matter* and *form* being the other two. But though the

* Ancient
Metaphy-
sics.

privation of *one* form be doubtless necessary before matter can receive another (for a piece of wax or clay cannot receive the form of a *globe* before it lose the form of a *square*), yet Aristotle never dreamed that the privation of the square was any property of the globe, or that *privation* itself was to be reckoned a real being. On the contrary, he expressly calls it *to μὴ οὐ*, or *the no being*. In this way, if we please, we may consider space, and call it the *privation of fulness* or of body. We have indeed a positive idea of it, as well as of silence, darkness, and other privations: but to argue from such an idea of space, that space itself is something real, seems altogether as good sense as to say, that because we have a different idea of *darkness* from that of *light*, of *silence* from that of *sound*, of the *absence* of any thing from that of its *presence*; therefore *darkness*, *silence*, *absence*, must be real things, and have as positive an existence as *light*, *sound*, and *body*: and to deny that we have any positive idea, or, which is the very same thing, any idea at all, of the privations above mentioned, will be to deny what is capable of the most complete proof (see n° 19.), and to contradict common sense and daily experience. There are therefore ideas, and simple ones too, which have nothing *ad extra* correspondent to them; no proper *idiatum*, archetype, or objective reality: and we do not see why the idea of space may not be reckoned of that number. To say that *space* must have existence, because it has some properties (for instance, *penetrability*, or the *capacity* of receiving body), seems† to be the same thing as to urge that *darkness* must be something because it has the capacity of receiving *light*; *silence* the property of admitting *sound*; and *absence* the property of being supplied by *presence*. To reason in this manner is to assign absolute negations; and such as, in the same way, may be applied to *nothing*, and then call them *positive properties*; and so infer that the chimera, thus clothed with them, must needs be something.

But it is said, that as we cannot conceive space to be annihilated, it must be some real thing of eternal and necessary existence. If this argument had not been used by writers of great merit, and with the best intention, we should not have scrupled to call it the most contemptible sophism that ever disgraced the page of philosophy. Whatever now has an *actual* existence, must from eternity have had a *possible* existence in the ideas of the Divine mind. Body, as an extended substance, has now an *actual* existence; and therefore it must from eternity have had a *possible* existence in the ideas of the Divine mind: but the *possible existence* of body is all that we can conceive by *space*; and therefore this argument, upon which so much stress has been laid, amounts to nothing more, than that what has from eternity been possible, can at no period have been impossible. It is evident that the *capacity* or *potentiality* of every thing existing must have been from eternity; but is capacity or potentiality a real being? All the men and women who shall succeed the present generation to the end of time, have at this moment a possibility of existence, nor can that possibility be conceived as an impossibility; but is it therefore any thing actually existing either as a substance or a quality?

It has been urged, that space must be something more than the mere absence of matter; because if nothing

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† See Notes
on King's
Origin of
Evil, and
Larv's En-
quiry into
the Ideas of
Space, &c.

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Space no-
thing but
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body.

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thing be between bodies, such as the walls of a room, they must necessarily touch. But surely it is not *self-evident* that bodies must necessarily touch if nothing be between them; nor of the truth of this proposition can any thing like a proof be brought. It is indeed intuitively certain, that "things, when they are in contact, have nothing between them;" and hence it has been rashly inferred, that things, when they have nothing between them, are in contact; but this is an illegitimate conversion of the proposition. Every logician knows, that to convert a proposition, is to infer from it another whose *subject* is the *predicate*, and whose *predicate* is the *subject*, of the proposition to be converted: but we are taught by Aristotle and by common sense, that an *universal* affirmative can be converted only into a *particular* affirmative. "Things, when they are in contact, have nothing between them," is an *universal* affirmative proposition; and therefore it can be converted only into the following *particular* affirmative: "Some things, when they have nothing between them, are in contact;" a proposition which by no means includes in it the contact of the walls of an empty room. The reason why the walls of an empty room do not touch, is that they are *distant*; but is *distance*, in the abstract, any thing really existing? Two individuals differ, or there is a difference between them; but is *difference* itself any real external thing? Bodies are long, broad, thick, heavy; but are *length*, *breadth*, *density*, *weight*, properly any thing? Have they any real separate archetypes or external idiata? Or can they exist but in some substance?

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The fallacy
which led
to the sup-
position
that space
is a real
thing.

The reason why so many philosophers have considered space as a real external thing, seems to be this: Every bodily substance is extended; but space is conceived to be that which contains body, and therefore to space we likewise attribute extension. Extension is a quality which can have no existence but as united with other qualities in some substance; and it is that of which, abstracted from all substances, we can, properly speaking, form no *idea*. We understand the meaning of the word, however, and can reason about that which it denotes, without regarding the particular substance in which extension may inhere; just as we can reason about whiteness without regarding any one white object, though it is self-evident that whiteness, abstracted from all objects, cannot figure in the mind as an *idea*. Qualities considered in this manner are general and relative notions, the objects of pure intellect, which make no appearance in the imagination, and are far less, if possible, to be perceived by sense: but it is extremely painful to the mind to dwell upon such notions; and therefore the ever-active fancy is always ready to furnish them with imaginary *substrata*, and to make that which was a *general* and *invisible* notion be conceived as a *particular* *ideal* object. In the case of extension this is the more easily done, that the notion which we have of a *real substratum* or substance, the support of real qualities, is obscure and relative, being the notion of *something* we know not what. Now, by leaving, if we can, solidity and figure out of our conception, and joining the notion of *something* with the notion of *extension*, we have at once the *imaginary substratum* of an *imaginary* quality, or the general notion of extension particularised in an imaginary subject; and this subject we call *space*, vainly fancying

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that it has a real external and independent existence. Whether this be not all that can be said of space, and whether it be not absurd to talk of its having any real properties, every man will judge for himself, by reflecting upon his own ideas and the manner in which they are acquired. We ourselves have no doubt about the matter. We consider pure space as a mere notion relative to the existence of corporeal substance, as nothing more than the absence of body, where body is possible; and we think the usual distinction between *absolute* and *relative* space, if taken as real, the grossest absurdity. We do not, however, pretend to dictate to others; but recommend it to every man to throw away all respect for great names, to look attentively into his own thoughts, and on this as on all metaphysical subjects to judge for himself.

Having said so much of space in general, we need not waste much time upon its modes. Indeed the only mode of space, after considering it with respect to the three dimensions of body, which now demands our attention, is that which we call *place*. As in the simplest mode of space we consider the relation of distance between any two bodies or points; so, in our idea of *place*, we consider the relation of distance betwixt any thing, and any two or more points, which, being considered as at rest, keep the same distance one from another. Thus, when we find any thing at the same distance now at which it was yesterday from two or more points with which it was then compared, and which have not since the comparison was made changed their distance or position with respect to each other, we say that the thing hath kept its *place*, or is in the *same place*; but if it hath sensibly altered its distance from either of those points, we then say that it hath changed its *place*.

From this view of the nature of place, we need not observe that it is a mere relation; but it may be worth while to advert to this circumstance, that a thing may without falsehood be said to have continued in the same place, and at the same time to have changed its place, according to the different objects with which it is compared. Thus, if two persons find a company of chess-men standing each upon the same square of the chess-board where they left them, the one may with truth affirm that they are all in the *same place*, or unmoved; and the other may with equal truth affirm that they have all changed *place*. The former considers the men only with respect to their distances from the several parts of the chess-board, which have kept the same distance and position with respect to one another. The latter must consider the men with respect to their distance from something else: and finding that the chess-board, with every thing upon it, has been removed, we shall suppose from one room to another, he cannot but say that the chess-men have changed their place with respect to the several parts of the room in which he formerly saw them.

This modification of distance, however, which we call *place*, being made by men for their common use, that by it they may design the particular position of objects where they have occasion for such designation, they determine this *place* by reference to such adjacent things as best serve their present purpose, without regarding other things which, for a different purpose, would better determine the place of the same object.

Thus.

Of Space
and its
Modes.

Thus in the chess-board, the use of the *designation of the place* of each chess-man being determined only within that chequered piece of wood, it would cross that purpose to measure it by any thing else: but when these very chess-men are put up in a box, if any one should ask where the black king is, it would be proper to *determine the place* by reference to something else than the chess-board; such as the parts of the room or closet which contain the box.

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The universe has
no place.

That our idea of *place* is nothing but such a relative position of things as we have mentioned, will be readily admitted, when it is considered that we can have no idea of the place of the *universe*. Every part of the universe has place; because it may be compared with respect to its distance from other parts supposed to be fixed. Thus the earth and every planet of our system has a place which may be determined by ascertaining its distance from the sun and from the orbits of the other planets; and the place of the system itself may be ascertained by comparing it with two or more fixed stars: but all the systems taken as *one whole* can have no *place*; because there is nothing else to which the distance and position of that whole can be referred. It is indeed true, that the word *place* is sometimes used, we think improperly, to denote that *space* or portion of *space* which any particular body occupies; and in this sense, no doubt, the universe has place, as well as the earth or solar system: but to talk of the place of the universe in the other and proper sense of the word, is the grossest nonsense.

CHAP. V. Of MOTION.

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Mobility
essential
to every
corporeal
substance,
but not natural
motion.

MOBILITY, or a capacity of being moved, is essential to every corporeal substance; and by actual motion are all the operations of nature performed. Motion, therefore, if it may be called an *adjunct* of body, is certainly the most important of all its adjuncts; and to ascertain its nature and origin demands the closest attention of the metaphysician, as well as of the mechanic and astronomer. With the *laws* of motion, as discovered by experience, we have at present no concern: they are explained and fully established in other articles of this work (see MECHANICS, MOTION, &c.). The principal questions which we have to consider are, "What is motion? and, By what power is it carried on?"

For an answer to the first of these questions, the modern metaphysician refers every man to his own senses; because, in his apprehension, the word motion denotes a simple idea which cannot be defined. Among the ancients, the Peripatetics were of a different opinion; and Aristotle, whose love of dialectic made him define every thing, has attempted to give two definitions of *motion*. As some learned men are at present labouring to revive this system, we shall, out of respect to them, mention those definitions, and make upon them such remarks as to us appear proper.

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The Peripatetic
definitions of
motion

The author of *Ancient Metaphysics* having observed, that both nature and art propose some end in all their operations; that when the end is obtained, the thing operated upon is in a state of perfection or completion; and that in the operations of both nature and art there is a progress, and by consequence a *change*,

N^o 214.

from one thing to another; adds, that this change is *motion*. Motion, therefore, according to him, is a change or progress to the end proposed, or to that state of perfection or completion which Aristotle calls *εντελεχεια*. It is not enough, however, that we know *to what* the change or progress is made: to have an adequate idea of motion, we must likewise know *from what* it proceeds. Now it is evident that every thing existing, whether by nature or art, was, before it existed, possible to exist; and therefore, adds the same author, things do in some sort exist even before they exist. This former kind of existence is said by Aristotle to be *εν δυναμει*, that is, in *power* or *capacity*. In this way, plants exist in their seeds; animals in the embryo; works of art in the idea of the artists and the materials of which they are made; and, in general, every thing in the causes which produce it. From this power or capacity there is a progress to *energy* or actual existence; so that we are now able to answer the question, "*from what*, and *to what*, motion is a change?" for it is universally true of all *motion*, that it is a change from *capacity* to *energy*.

"Having thus discovered that *motion* lies betwixt *capacity* and *energy*, it is evident (he says) that it must have a connection with each of them: and from this double connection Aristotle has given us two definitions of it; one of them taken from the *energy*, or end to which it tends; the other from the *capacity* from which it begins. The first is expressed in two words, viz. *ενεργεια ατελης*, or *imperfect energy*; the other is *εντελεχεια του εν δυναμει η εν δυναμει*; which may be translated thus, *The perfection of what is in capacity, considered merely as in capacity*. The meaning of the last words is, that nothing is considered in the thing that is moved but merely its *capacity*; so that motion is the perfection of that capacity, but not of the thing itself. It is something more (adds the learned author) than mere *capacity*; for it is capacity exerted, which when it has attained its end, so that the thing has arrived at that state to which it is destined by nature or art, ceases, and the thing begins to exist *ενεργεια*, or *actually*."

By all the admirers of Aristotle, this latter definition has been preferred to the former; for what reason, it is difficult to say. They both involve in the thickest obscurity that which, viewed through the senses, is very easily understood; and on this, as on many other occasions, Aristotle was certainly guilty of darkening counsel by words without knowledge. The author, whose comment on this wonderful definition we have faithfully abridged, admits that it is not intelligible till we know what *change* and *progress* are; but is it possible to conceive any *change* to take place in bodily substances without *motion*? or, if we were called upon to explain what progress is, could we do it better than by saying that it is motion *from something to something*? It is likewise very obvious, that before we can have an adequate idea of *motion*, we must, according to this definition, know perfectly what the words *capacity*, *energy*, and *perfection* denote; and yet nothing can be more true than that *perfection* denotes a complex conception, which may be easily defined by resolving it into the simple ideas and notions of which it is compounded, whilst *motion* is susceptible of no such resolution. The perfection of a knife is compounded of the temper of the steel and the

Of Motion.

Of Motion.

the sharpness of the edge: the perfection of a system of philosophy consists of the importance of the subjects treated, the strength of the author's arguments, and the perspicuity of his style and manner; but of what is the *motion* of a ball, or an *atom*, or any thing else, compounded? We are aware that to this question the modern Peripatetics will reply, that it is not the motion of a ball, or an *atom*, or any *one thing*, that their master has so learnedly defined, but motion abstracted from *all individuals*, and made an object of pure intellect; and they will likewise affirm, that by the word *perfection* used in the definition, he does not mean *any one kind* of perfection as adapted to any particular *object* or *end*, but perfection abstracted from *all objects* and *all ends*. The perfection of *nothing* and the motion of *nothing*, for such surely are that motion and that perfection which are abstracted from *all objects* and *ends*, are strange expressions. To us they convey no meaning; and we have reason to think that they are equally unintelligible to men of greater acuteness (o). In a word, *motion* must be seen or felt; for it cannot be defined. To call it the *act of changing place*, or a *passage from one place to another*, gives no information; for *change* and *passage* cannot be conceived without previously conceiving *motion* (p).

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The Peripatetic division of motion absurd.

The Peripatetics having idly attempted to *define* motion, proceed next to *divide* it into four kinds or classes. This division was by the father of the school pretended to be made from the effects which it produces, and was said by him to belong to three categories, viz. *quality*, *quantity*, and *where* (see CATEGORY). The first kind is that well known *motion from place to place*, which falls under the category last mentioned; the second is *alteration*, by which the quality of any thing is changed, the substance remaining the same. This belongs to the category of *quality*. The third is *increase*, and the fourth *diminution*, both belonging to the category of *quantity*. The ancient

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atomists, and all the modern metaphysicians of eminence, have with great propriety rejected this division as being nothing but a collection of absurd distinctions where there is in nature no difference. It has been already shown, that body has no other real qualities than *solidity*, *extension*, and *figure*: but of these the first cannot be altered without destroying the substance; for every thing which is material is equally solid. The extension of a body may indeed be enlarged, and its figure may be altered, while the substance remains the same; but that alteration can be made only by moving from their *places* the solid atoms of which the body is composed. Aristotle's second kind of motion therefore differs not from the first; nor do the third and fourth differ from these two. For a body cannot be *increased* without acquiring new matter, nor diminished without losing some of the matter of which it was originally composed: but matter can neither be added nor taken away without motion from place to place; for there is now no creation *de novo*; and we have no reason to imagine that, since the original creation, a single atom has been ever annihilated. It is therefore past dispute, that local motion is the only motion conceivable; and indeed, as far as we are capable of judging from what we know of body, it is the only motion possible.

This has given rise to a question which has been debated among modern philosophers, though, as far as we know, it was never agitated among the ancients, viz. "Whether if there were but one solid body existing, that body could possibly be moved." Bishop Berkeley seems to be of opinion that it could not; because no motion can be conceived but what has a direction towards some *place*, and the relation of place necessarily supposes the existence of two or more bodies. Were all bodies, therefore, annihilated except one globe, it would be impossible (he thinks) to conceive that globe in motion (q.) With respect to

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Whether, if but one body existed, there could be motion?

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(o) "Nunc dicendum de natura motus. Atque is quidem, cum sensibus clare percipiatur, non tam natura sua, quam doctis philosophorum commentis obscuratus est. Motus nunquam in sensus nostros incurrit sine mole corporea, spatio et tempore. Sunt tamen qui motum, tanquam ideam quandam simplicem et abstractam, atque ab omnibus aliis rebus *sejunctam*, contemplari student. Verum idea illa tenuissima et subtilissima *intellectus aciem eludit*: id quod quilibet secum meditando experiri potest. Hinc nascuntur magnæ difficultates de natura motus, et definitiones, ipsa re quam illustrare debent longe obscuriores. Hujusmodi sunt definitiones illæ Aristotelis et scholasticorum, qui motum dicunt esse *actum mobilis quatenus est mobile*, vel, *actum entis in potentia quatenus in potentia*. Hujusmodi etiam est illud viri inter recentiores celebris, qui asserit *nihil in motu esse reale præter momentaneum illud quod in vi ad mutationem nitente consistit*. Porro constat, horum et similium definitionum auctores in animo habuisse abstractam motus naturam, seclusa omni temporis et spatii consideratione, explicare: sed qua ratione abstracta illa motus quintessentia (ut ita dicam) intelligi possit non video."

Berkeley de Motu.

(p) "Multi etiam per *transitum* motum definiunt, obliti scilicet transitum ipsum sine motu intelligi non posse, et per motum definiri oportere: Verissimum adeo est definitiones, sicut nonnullis rebus lucem, ita vicissim aliis tenebras asferre. Et profecto, quascumque res sensu percipimus, eas clariores aut notiores definiendo efficere vix quisquam potuerit. Cujus rei vana spe allecti res faciles difficillimas reddiderunt philosophi, mentesque suas difficultatibus, quas ut plurimum ipsi peperissent, implicavere." *Id. ibid.*

(q) Having proved that *place*, in the proper sense of the word, is merely relative, and affirmed that all *motion* is relative likewise, the Bishop proceeds thus: "Veruntamen ut hoc clarius appareat, animadvertendum est, motum nullum intelligi posse sine determinatione aliqua seu directione, quæ quidem intelligi nequit, nisi præter corpus motum, nostrum etiam corpus, aut aliud aliquid, simul intelligatur existere. Nam sursum, deorsum, sinistrorsum, dextrorsum, omnesque plagæ et regiones in relatione aliqua fundantur, et necessario corpus a moto diversum connotant et supponunt. Adeo ut, si, reliquis corporibus in nihilum reductis, globus, exempli gratia, unicus existere supponatur; in illo motus nullus concipi possit: usque adeo necesse est, ut

detur

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the origin of our *ideas* of motion, his reasoning appears unanswerable; but we do not perceive how it concludes against the possibility of motion itself as existing in a single body. It has been already shown in the chapter of *simple apprehension and conception*, that though nothing can be conceived which may not possibly exist, yet many things may be possible which we have not faculties or means to conceive. In the present instance, were this solitary globe animated as our bodies are, were it endowed with all our senses and mental powers, it certainly would not acquire any *idea* of motion though impelled by the greatest force. The reason is obvious; it would have no objects with which to compare its place and situation at different periods of time; and the experience of a ship at sea in calm weather, affords sufficient proof that motion which is equable cannot be perceived by any other means than by such a comparison. When the waves swell and the ship pitches, it is indeed impossible that those who are on board should not perceive that they are actually in motion; but even this perception arises from comparing their position with that of the waves rising and falling around them: whereas in the regions of empty space the animated globe could compare its position with nothing; and therefore, whether impelled by equal or unequal forces, it could never acquire the *idea* of motion. It may perhaps be thought, that if this solitary globe were a *self-moving* animal, it might acquire the *idea* of motion by inferring its existence from the energy which produced it. But how, we would ask, could an animal in such circumstances be *self-moving*? Motion is the effect of some cause; and it has been already shown (see n° 118. of this article), that we have no reason to suppose that any being can be the *real* and *primary* cause of any effect which that being can neither conceive nor will: but as motion can be perceived only by the senses, a solitary animal could have no *idea* of motion previous to its own exertions; and therefore could neither conceive, nor will, an exertion to produce it. Let us, however, suppose, that without any end in view it might spontaneously exert itself in such a manner as would produce *sensible* motion, were it surrounded with other corporeal objects; still we may venture to affirm, that so long as it should remain in absolute solitude, the being itself would acquire no *idea* of motion. It would indeed be *conscious* of the *mental* energy, but it could not infer the existence of motion as a consequence of that energy; for the *idea* of motion can be acquired only by sense, and by the supposition there are no objects from which the senses of this spherical animal could receive those impressions, without which there can be no perception, and of course no *ideas*.

Let us now suppose, that, while this animated globe is under the influence either of external impulse or its own spontaneous energy, other bodies are suddenly brought into existence: would it then acquire the *idea* of motion? It certainly would, from perceiving its own change of place with respect to those bodies; and though at first it would not perhaps be able to determine whether itself or the bodies around it were moving, yet a little experience would decide this question likewise, and convince it that the motion was the effect either of its own *mental energy*, or that external *impulse* which it had felt before the other bodies were presented to its view. But it is obvious, that the creation of new bodies at a distance, can make no real alteration in the state of a body which had existed before them: and therefore, as this animated globe would now *perceive* itself to be moving, we may infer with the utmost certainty that it *was moving* before; and that the motion of a single body, though not *perceivable* by the senses, might possibly be produced in empty space.

Having thus seen that a single body is capable of motion in empty space, the next question that occurs on this subject is, Whether it would be possible to move a body in space that is absolutely full? Such are the terms in which this question is usually put; and by being thus expressed, it has given rise to the dispute among natural philosophers about the existence of a *vacuum*. Perhaps the dispute might have been avoided had the question been more accurately stated. For instance, had it been asked, Whether motion would be possible, could matter be supposed absolutely infinite without any the least interstice or vacuity among its solid parts? we apprehend that every reflecting man would have answered in the negative. At any rate, the question ought to be thus stated in metaphysics; because we have seen that space, though a positive term, denotes nothing really existing. Now it being of the very essence of every solid substance to exclude from the place which it occupies every other solid substance, it follows undeniably, that not one particle of an infinite solid could be moved from its place without the previous annihilation of another particle of equal extent; but that annihilation would destroy the infinity. Were matter extended to any degree less than infinity, the motion of its parts would undoubtedly be possible, because a sufficient force could separate those parts and introduce among them vacuities of any extent; but without vacuities capable of containing the body to be moved, it is obvious that no force whatever could produce motion. This being the case, it follows, that however far we suppose the material universe extended, there must be vacuities

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Answered in the affirmative.

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Whether motion would be possible in space absolutely full?

detur aliud corpus, cujus situ motus determinari intelligatur. Hujus sententiæ veritas clarissima elucebit, modo corporum omnium tam nostri quam aliorum, præter globum istum unicum, annihilationem recte supposuerimus.

“Concipiantur porro duo globi, et præterea nihil corporeum, existere. Concipiantur deinde vires, quomodocunque applicari: quicquid tandem per applicationem virium intelligamus, motus circularis duorum globorum circa commune centrum nequit per imaginationem concipi. Supponamus deinde cælum fixarum creari: subito ex concepto appulsu globorum ad diversas cæli istius partes motus concipietur. Scilicet cum motus natura sua sit relativus, concipi non potuit priusquam darentur corpora correlata. Quemadmodum nec ulla relatio alia sine correlatis concipi potest.”

De Motu.

Of Mo-
tion.Of Mo-
tion.194
Bodies e-
qually in-
different to
motion and
rest.195
Motion
produced
by impulse
can only
be in a
straight
line.196
The New-
tonian doc-
trine re-
specting the
causes of
the motion
of the hea-
venly be-
dies.197
Mutual at-
traction a-
mong the
heavenly
bodies im-
possible.

vacuities in it sufficient to permit the motion of the planets and all the other heavenly bodies, which we plainly perceive to revolve round a centre: and if so, the next question to be determined is, What can *in vacuo* operate upon such immense bodies, so as to produce a regular and continued motion?

That all bodies are equally capable of motion or rest, has by natural philosophers been as completely proved as any thing can be proved by observation and experience. It is indeed a fact obvious to the most superficial observer; for if either of these states were essential to matter, the other would be absolutely impossible. If rest were essential, nothing could be moved; if motion were essential, nothing could be at rest, but every the minutest atom would have a motion of its own, which is contrary to universal experience. With respect to motion and rest, matter is wholly passive. No man ever perceived a body inanimated begin to move, or when in motion stop without resistance. A billiard ball laid at rest on the smoothest surface, would continue at rest to the end of time, unless moved by some force extrinsic to itself. If such a ball were struck by another ball, it would indeed be moved with a velocity proportioned to the impetus with which it was struck; but the impelling ball would lose as much of its own motion as was communicated to that upon which the impulse was made. It is evident, therefore, that in this instance there is no *beginning* of motion, but only the communication of motion from one body to another; and we may still ask, Where had the motion its origin? If the impelling ball was thrown from the hand of a man, or struck with a racket, it is plain that by a volition of the man's mind the motion was first given to his own arm, whence it proceeded through the racket from one ball to another; so that the ball, racket, and arm, were mere instruments, and the mind of the man the only agent or first mover. That motion can be *begun* by any being which is not possessed of life, consciousness, and will, or what is analogous to these, is to us altogether inconceivable. Mere matter or inanimated body can operate upon body only by impulse: but impulse, though from the poverty of language we are sometimes obliged to talk of its agency, is itself merely an effect; for it is nothing more than the contact of two bodies, of which one at least is in motion. An infinite series of effects without a cause is the grossest absurdity; and therefore motion cannot have been communicated from eternity by the impulse of body upon body, but must have been originally pro-

duced by a being who acts in a manner analogous to the energies of the human will.

But though motion could not have been begun but by the energy of mind, it is generally believed that it might be continued by the mere passivity of body; and it is a law of the Newtonian philosophy, that a body projected in empty space would continue to move in a straight line for ever. The only reason which can be assigned for this law is, that since body continues to move at all after the impetus of projection has ceased, it could not of itself cease to move without becoming active; because as much force is required to stop a body in motion as to communicate motion to the same body at rest. Many objections have been made to this argument, and to the law of which it is the foundation; but as we do not perceive their strength, we shall not fill our page with a formal examination of them (R). If a single body could exist and have motion communicated to it *in vacuo* by the force of projection, we are persuaded, that from the very passivity of matter, that motion would never have an end; but it is obvious that it could be moved only in a straight line, for an impulse can be given in no other direction.

The heavenly bodies, however, are not moved in straight lines, but in curves round a centre; and therefore their motion cannot have been originally communicated merely by an impressed force of projection. This is admitted by all philosophers; and therefore the Newtonians suppose that the planets are moved in elliptical orbits by the joint agency of two forces acting in different directions. One of these forces makes the planet tend directly to the centre about which it revolves; the other impels it to fly off in a tangent to the curve described. The former they call *gravitation*, which some of them have affirmed to be a property inherent in all matter; and the latter, which is a projectile force, they consider as impressed *ab extra*. By the joint agency of such forces, duly proportioned to each other, Sir Isaac Newton has demonstrated, that the planets must necessarily describe such orbits as by observation and experience they are found actually to describe. But the question with the metaphysician is, Whether such forces be real?

With respect to projection, there is no difficulty; but that bodies should mutually act upon each other at a distance, and through an immense vacuum, seems at first sight altogether impossible. If the planets are moved by the forces of gravitation and projection, they must necessarily move *in vacuo*; for the continual

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resistance possible.

(R) By much the strongest and best urged of these objections which we have seen, is made by Dr Horsely, a man equally learned in mathematics and in ancient and modern philosophy. "I believe with the author of *Ancient Metaphysics* (says he), that some active principle is necessary for the continuance as well as for the beginning of motion. I know that many Newtonians will not allow this: I believe they are misled, as I myself have formerly been misled, by the expression *a state of motion*. Motion is a change; a continuance of motion is a farther change; a farther change is a repeated effect; a repeated effect requires a repeating cause. State implies the contrary of change; and motion being change, a *state of motion* is a contradiction in terms." See *Ancient Metaphysics*, Vol. II.

If our readers think this reasoning conclusive, they may be in the right; and in that case they will see the necessity of admitting, even for the continuance of rectilinear motion, the *plastic nature*, or something equivalent to it, without which we have endeavoured to prove that the heavenly bodies could not revolve round their respective centres in elliptical curves.

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tion.

resistance of even the rarest medium would in time overcome the force of the greatest impetus: but if they move *in vacuo*, how can they be attracted by the sun or by one another? It is a self-evident truth, that nothing can act but where it is present, either immediately or mediately; because every thing which operates upon another, must perform that operation either by its own immediate agency or by means of some instrument. The sun and planets are not in contact; nor, if the motion of these bodies be *in vacuo*, can any thing material pass as an instrument from the one to the other. We know indeed by experience, that every particle of unorganised matter within our reach has a tendency to move towards the centre of the earth; and we are intuitively certain, that such a tendency must have some cause: but when we infer that cause to be a power of attraction inherent in all matter, which mutually acts upon bodies at a distance, drawing them towards each other, we talk a language which is perfectly unintelligible (s). Nay more, we may venture to affirm that such an inference is contrary to fact. The particles of every elastic fluid fly from each other; the flame of a fire darts upwards with a velocity for which the weight of the circumambient air cannot account; and the motion of the particles of a plant when growing, is so far from tending toward the centre of the earth, that when a flowerpot is inverted, every vegetable in it, as soon as it is arrived at a sufficient length, bends itself over the side of the pot, and grows with its top in the natural position.

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The heavenly bodies cannot be moved by two forces impressed *ab extra*;

Sensible of the force of these arguments against the possibility of an attractive power in matter which operates at a distance, other philosophers have supposed

that the heavenly bodies are moved in elliptical orbits by means of two forces originally impressed upon each planet impelling it in different directions at the same time. But if the tendency of the planets towards the centre of the sun be of the same kind with that of heavy bodies towards the centre of the earth (and if there be such a tendency at all, we have no reason to suppose it different), it cannot possibly be the effect of impulse. A body impelled or projected *in vacuo* would continue to be moved with an equable velocity, neither accelerated nor retarded as it approached the object towards which it was directed; but the velocity of a body tending towards the centre of the earth is continually accelerated: and as we cannot doubt but that the same thing takes place in the motion of a body tending towards the centre of the sun, that motion cannot be the effect of impulse or projection.

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tion

Some of the Newtonians therefore have supposed, ¹⁹⁹ Nor by the agency of any material fluid. "That all kinds of attraction consist in fine imperceptible particles or invisible effluvia, which proceed from every point in the surface of the attracting body, in all right-lined directions every way; which in their progress lighting on other bodies, urge and solicit them towards the superior attracting body; and therefore (say they) the force or intensity of the attracting power in general must always decrease as the squares of the distances increase." The inference is fairly drawn from the fact, provided the fact itself were real or possible: but it is obvious, that if fine imperceptible particles or invisible effluvia were thus issued from every point in the surface of the sun, the earth and other planets could not move *in vacuo*; and therefore the projectile motion would in time be stopped by the resistance.

(s) Since this article was finished for the press, Professor Stewart's *Elements of the Philosophy of the Human Mind* have been given to the public; a work of which the merit is such as to make it painful to us to differ in any important opinion from the ingenious author. We shall, however, claim the same liberty of dissenting occasionally from him that he has claimed of dissenting from Newton, Locke, Clarke, and Cudworth, from whom he differs widely in thinking it as easy to conceive how bodies can act upon each other at a distance, as how one body can communicate motion to another by impulse. "I allow (says he, p. 79.), that it is impossible to conceive in what manner one body acts upon another at a distance through a vacuum; but I cannot admit that it removes the difficulty to suppose, that the two bodies are in actual contact. That one body may be the efficient cause of the motion of another body placed at a distance from it, I do by no means assert; but only that we have as good reason to believe that this may be possible, as to believe that any one natural event is the efficient cause of another."

If by *efficient* cause be here meant the *first* and *original* cause of motion, we have the honour to agree with the learned Professor; for we are persuaded that body inanimated is not, in this sense of the word, the cause of motion either at hand or at a distance: but if he mean (and we think he must, because such was the meaning of Newton, from whom he professes to differ), that we can as easily conceive one body to be the instrumental cause of the motion of another from which it is distant, as we can conceive it to communicate motion by impulse, we cannot help thinking him greatly mistaken. We will not indeed affirm, with the writer whom he quotes, "that although the experiment had never been made, the communication of motion by impulse might have been predicted by reasoning *à priori*;" because we are not certain, that without some such experiment we should ever have acquired adequate notions of the solidity of matter: But if all corporeal substances be allowed to be solid and possessed of that negative power to which philosophers have given the name of *vis inertiae*, we think it may be easily proved *à priori*, that a sufficient impulse of one hard body upon another *must* communicate motion to that other; for when the *vis inertiae*, by which alone the one body is kept in its place, is less than the *vis impetus* with which the other rushes to take possession of that place, it is evident that the former body *must* give way to the latter, which it can do only by motion, otherwise the two bodies would occupy one and the same place, which is inconsistent with their solidity. But that a substance possessed of a *vis inertiae* should make another substance possessed of the same negative power quit a place to which itself has no tendency, is to us not only *inconceivable*, but apparently impossible, as implying a direct contradiction.

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ance of this powerful medium. Besides, is it not altogether inconceivable, nay impossible, that particles issuing from the sun should draw the planets towards that centre? would they not rather of necessity drive them to a greater distance? To say, that after they have reached the planets, they change their motion and return to the place whence they set out, is to endue them with the powers of intelligence and will, and to transform them from passive matter to active mind.

These difficulties in the theories of attraction and impulse have set philosophers upon fabricating numberless hypotheses: and Sir Isaac Newton himself, who never considered gravitation as any thing more than an effect, conjectured that there might be a very subtle fluid or ether pervading all bodies, and producing not only the motion of the planets, and the fall of heavy bodies to the earth, but even the mechanical part of muscular motion and sensation. Others (τ) again have supposed fire, or light, or the electric fluid, to be the universal agent; and some few (υ) have acknowledged, that nothing is sufficient to produce the phenomena but the immediate agency of mind.

With respect to the interposition of any material fluid, whether ether, fire, light, or electricity, it is sufficient to say that it does not remove any one difficulty which encumbers the theory of innate attraction. All these fluids are elastic; and of course the particles of which they are composed are distant from each other. Whatever motion, therefore, we may suppose to be given to one particle or set of particles, the question still recurs, How is it communicated from them to others? If one body can act upon another at the distance of the ten-thousandth part of an inch, we can perceive nothing to hinder its action from extending to the distance of ten thousand millions of miles. In the one case as well as the other, the body is acting where it is not present; and if that be admitted to be possible, all our notions of action are subverted, and it is vain to reason about the cause of any phenomenon in nature.

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The hypothesis of
Plato, Aristotle, and
Cudworth,

This theory of the intermediate agency of a subtle fluid differs not essentially from the vortices of Des Cartes; which appeared so very absurd to Cudworth, that with a boldness becoming a man of the first genius and learning, he rejected it, and adopted the plastic nature of Plato, Aristotle, and other Greek philosophers. That incomparable scholar observes, that matter being purely passive, the motion of the heavenly bodies, the growth of vegetables, and even the formation of animal bodies, must be the effect either of the immediate agency of God, or the agency of a *plastic nature* used as an instrument by divine wisdom. That they are not the effect of God's immediate agency, he thinks obvious from several circumstances. In the first place, they are performed slowly and by degrees, which is not suitable to our notions of the agency of almighty Power. Secondly, Many blunders are committed in

the operations of nature, such as the formation of monsters, &c. which could never be were things formed by the immediate hand of God. He is therefore of opinion, that, after the creation of matter, God employed an inferior agent to give it motion and form, and to carry on all those operations which have been continued in it since the beginning of the world. This agent he calls *plastic nature*; and considers it as a being incorporeal, which penetrates the most solid substance, and, in a manner which he pretends not to explain otherwise than by analogy, actuates the universe. He does not look upon it as a being endued with perception, consciousness, or intelligence; but merely as an instrument which acts under divine wisdom according to certain laws. He compares it to art embodied; and quoting from Aristotle, says, *ΕΙ ΕΝΗΝ ΕΝ ΤΩ ΞΥΛΩ Η ΑΥΤΟΠΡΑΞΗ ΟΜΟΙΩΣ ΑΝ ΤΗ ΦΥΣΕΙ ΕΡΧΕΤΑΙ*. *If the art of the shipwright were in the timber itself, operatively and effectually, it would there act just as nature doth.* He calls it a certain lower life than the animal, which acts regularly and artificially for ends of which it knows nothing. It may be, he says, either a lower faculty of some conscious soul, or else an inferior kind of life or soul by itself, but depending in either case upon a higher intellect. He is aware with what difficulty such a principle will be admitted by those philosophers who have divided all being into such as is extended and such as is cogitative: but he thinks this division improper. He would divide beings into those which are solid and extended, and those which have life or internal energy. Those beings which have life or internal energy he would again divide into such as act with consciousness, and such as act without it: the latter of which is this plastic life of nature. To prove that such an instrument is possible, or that a being may be capable of operating for ends of which it knows nothing, he instances *bees* and other animals, who are impelled by *instinct* to do many things necessary to their own preservation, without having the least notion of the purpose for which they work. (See INSTINCT.) He observes, that there is an essential difference between reason and instinct, though they are both the attributes of mind or incorporeal substance: and that therefore, as we know of two kinds of mind differing so widely, there is nothing to hinder us from inferring a third, with powers differing as much from instinct as instinct differs from reason. Mankind are *conscious* of their own operations, *know* for what *purpose* they generally act, and can by the power of *reflection* take a *retrospective* view of their actions and thoughts, making as it were the mind its own object. Brutes are *conscious* of their own operations, but they are ignorant of the *purposes* for which they operate, and altogether *incapable* of *reflecting* either upon their past conduct or past thoughts. Between their intellectual powers and those of man, there is a much greater difference than there is between them and a plastic nature, which acts as an instrument of divine wisdom without any consciousness of its own operations. Aristotle, from whom principally the

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(τ) The several followers of Mr Hutchinso.

(υ) Cudworth, Berkeley, and the author of Ancient Metaphysics.

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the learned author takes his notion of this plastic nature, compares it, with respect to the divine Wisdom which directs and superintends its operations, to a mere builder or mechanic working under an architect, for the purpose of which the mechanic himself knows nothing. The words of the Stagyrice are:

Τους ἀρχιτέκτονας περὶ ἑκάστον τιμωμένους καὶ μάλλον εἰδέναι νομίζομεν τῶν χειροτέχων, καὶ σοφωτέρους οἶντας αἰτίας τῶν ποιουμένων ἰσάσιν οἱ δ' ὥσπερ καὶ τῶν ἀψυχῶν ἵνα, ποιεῖ μὲν, οὐκ εἰδὼς δὲ ποιεῖ, οἷον καὶ τὸ πῦρ· τὰ μὲν οὖν ἀψυχὰ φύσει τινὶ ποιεῖν τούτων ἕκαστον τοὺς δὲ χειροτέχνους διέθεος *.

• Metaphys. Lib. i. chap. i.

“We account the architects in every thing more honourable than the mere workmen, because they understand the reason of the things done; whereas the other, as some inanimate things, only work, not knowing what they do, just as the fire burns: the difference between them being only this, that inanimate things act by a certain nature in them, but the workman by habit.”

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shown to
be possible.

Still further to prove that a being may be endowed with some vital energy of a subordinate kind, and yet be destitute of consciousness and perception, the learned author observes, that there is no reason to think that the souls of men in sound sleep, lethargies, or apoplexies, are conscious of any thing; and still less, if possible, to suppose that the souls of embryos in the womb are from the very first moment of their arrival there intelligent and conscious beings: neither can we say, how we come to be so differently affected in our souls by the different motions made upon our bodies, nor are we conscious always of those energies by which we impress fantastic ideas on the imagination. But if it be possible for the souls of men to be for one instant void of consciousness and intelligence, it follows, that consciousness is not absolutely necessary to those energies and motions by which life is preserved. To this it may be added, upon the best authority†, “that where animal or vegetable life is concerned, there is in every case a different relation between the cause and effect, and seemingly depending upon the concurrence or influence of some farther principle of change in the subject, than what subsists in inanimate matter, or in the causes and effects that are the objects of mechanical and chemical philosophy.” Now to this prin-

† Gregory's Philosophical and Literary Essays.

ciple of vegetable life, without which, in a seed or in a plant, vegetation will neither begin nor continue, tho' light, heat, air, earth, and water, should concur in the utmost perfection, Cudworth expressly compares his plastic nature in the universe. It is so far (says he) from being the first or highest life, that it is indeed the last and lowest of all lives, being really the same thing with the vegetative.

These arguments, if the phenomena of elective attractions in chemistry be added to them, demonstrate, we think, the possibility of such a principle: and to those who are inclined to affirm that no such thing can exist, because, according to the description of it given by Cudworth and the ancients, it is neither body nor spirit, in the proper sense of the words; we beg leave to ask in the words of Locke, “Who told them that there is and can be nothing but solid beings which cannot think, and thinking beings that are not extended? which is all that they mean by the terms body and spirit.” All the Greek philosophers who were not materialists, and even the inspired writers of the Old and New Testaments, constantly distinguish between the *spirit* and the *soul* of a man, calling the former sometimes *vous* and sometimes *πνεῦμα*, and the latter *ψυχή*; and St Paul, who before he was a Christian was learned in philosophy, describes the constituent parts of man as three, *πνεῦμα*, *ψυχή*, *σῶμα*, *spirit*, *soul*, and *body*. This distinction, setting aside the authority with which it comes to us, seems to be well founded; for there are many operations carried on in the human body without any conscious exertion of ours, and which yet cannot be accounted for by the laws of mechanism. Of these, Cudworth instances the motion of the diaphragm and other muscles which causes respiration, and the systole and diastole of the heart; neither of which, he thinks, can be the effect of mere mechanism. But, as we are not conscious of any energy of soul from which they proceed, even while we are awake, and still less, if possible, while we are asleep; he attributes them, not to the intellect or rational mind, but to this inferior vital principle called *ψυχή* (*v*); which, in his opinion, acts the

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Arguments
for its truth:
but

(v) The existence of this plastic nature was warmly debated between Monsieur Le Clerc and Monsieur Bayle. Mosheim, who was inclined himself to admit such a principle, gives the following view of Le Clerc's sentiments from *Bibliothèque choisie*, tom. ii. p. 113. “Respiratio, inquit, et motus cordis, actiones sunt, quorum nihil ad animam pertinet. Interim mechanice eas fieri, nullo modo probabile est. In voluntariis commotionibus nesciunt animi nostri, quid facto opus sit, ut membra commoveantur: imperant illi tantum. Est vero aliud nescio quid, quod fideliter, si modo organa recte sint affecta, mandata ejus exsequitur. Quidni igitur suspicemur, esse naturam in corpore nostro viventem, præter animam nostram, cujus sit animæ præceptis et jussis morem gerere? quamquam potentia ejus ita sit definita, ut obedire nequeat animo, nisi recte sese habeant organa. Eadem forte natura, corporis nostri motibus impulsâ, animam edocet, quid factum sit, ut ille possit præcipere, quæ ad conservationem corporis necessaria judicat. Anima, pergit, si hæc vera esse putes, similis erit domino, sibi met ipsi servire nescio, nec ulla facultate alia, quam imperandi et jubendi instructo. Hæc vero natura si rectrix non dissimilis erit mancipii cui nihil eorum, quæ dominus meditat, notum est, quodque nihil aliud facit, quam ut jussis pareat, et dominum de illis rebus admoneat, quæ ad salutem ipsius pertinent.” Mosheim proceeds,—Si quis huic loco sic occurrat, Hæc ratione tria fingi in homine principia; respondet vir doctus: “Nullis constares argumentis, binis tantum hominem partibus constare. Eos, qui hominem ex binis tantum partibus component, nulla ratione explicare posse naturam conjunctionis animi et corporis, nisi ipsum Deum statuunt cunctis actionibus hominum intervenire: hoc vero Divina Majestate prorsus indignum esse. Definitionem accuratam mediæ hujus naturæ postulantibus sese talem dare non posse definitionem respondet: Hoc unum sese scire: esse eam naturam interiori agendi virtute instructam, quæ ex se et animam et corpus afficere queat; naturam, quæ doceat animam quid rerum

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the same part in the system of the human body which the plastic nature acts in the system of the world.— To make the resemblance more striking, he observes, that even the voluntary motion of our limbs, though it proceeds ultimately from an energy of will, seems to be the effect of that energy employing some *instrument* which pervades the sinews, nerves, and muscles of the body; and if the human spirit or *πνεῦμα* employ the instrumentality of a plastic nature or *ψυχὴ* in moving the small machine of the body, it seems to be far from incredible that the Divine Wisdom should employ the instrumentality of a plastic nature in moving the great machine of the universe.

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Whether it be true or not, the motions of the heavenly bodies are carried on by the constant agency of something incorporeal.

But we need not insist further on the *possibility* of such an instrument. Whatever may be thought of the arguments of Cudworth, of which some are, to say the least of them, plausible, though others appear to us to have very little strength, Dr Clarke has proved, with a force of reasoning not inferior to mathematical demonstration, that the motions of the heavenly bodies are carried on by the agency of something very different from matter, under every possible form. “For, not to say that, seeing matter is utterly incapable of obeying any *laws* in the proper sense of the word, the very original laws of motion themselves cannot continue to take place, but by something superior to matter, *continually* exerting on it a certain force or power according to such certain and determinate laws; it is now evident beyond question, that the bodies of all *plants* and *animals* could not possibly have been formed by mere matter according to any general laws of motion. And not only so, but that most universal principle of *gravitation* itself, the spring of almost all the great and regu-

lar inanimate motions in the world, answering not at all the *surfaces* of bodies, by which alone they can act upon one another, but entirely to their *solid contents*, cannot possibly be the result of any motion originally impressed upon matter.” For though it is true, that the most solid bodies with which we are acquainted are all very porous; and that, therefore, a subtle material fluid might penetrate the bodies of the planets, and operate upon them with a force exerted internally; still it is self-evident, that the *greatest* quantities of such a fluid could not enter into those bodies which are *least* porous, and where the greatest force of *gravitation* resides: “and, therefore, this motion must of necessity be caused by something which penetrates the very *solid substance* of all bodies, and continually puts forth in them a force or power entirely different from that by which matter acts upon matter †.” Which is, as the same able writer observes, an evident demonstration, not only of the world’s being originally made by a supreme intelligent Cause; but moreover, that it depends every moment upon some superior Being, for the preservation of its frame; and that all the great motions in it are caused by some immaterial power *perpetually* and *actually* exerting itself every moment in every part of the corporeal universe. This preserving and governing power, whether it be the immediate power and action of the same Supreme Cause that created the world, or the action of some subordinate instruments appointed by him to direct and preside respectively over certain parts thereof, gives us equally in either way a very noble idea of Providence. We know with certainty, that *real* and *original power* can belong only to a being endowed with intelligence and will; and, therefore, if the existence of Cudworth’s (w) plastic nature be

† Evidences of Nat. and Revealed Religion.

rerum geratur in corpore; naturam denique, quæ animi mandatis, quorum tamen causas nesciat, fideliter obtemperet.” Reliqua, quæ illustrandæ hujus rei causa CLERICUS affert, prætereo. Satis copiosa est in illis, quæ produximus, meditandi materia. *Mosheim. ed. Syst. Intellect. p. 173.*

Such a principle actuating the universe, if it be divested of intelligence, and considered as a second or inferior cause, under the direction of the Supreme, is acknowledged by a very able judge to be a rational hypothesis; and such, if properly pursued, would certainly open a most entertaining scene of natural philosophy. See *Jones’s Answer to an Essay on Spirit.*

(w) Besides Cudworth, we have mentioned Berkeley and the author of *Ancient Metaphysics*, as holding all motion to be an effect of the immediate agency of mind or incorporeal substance. The opinion of the last of these philosophers is not essentially different from Cudworth’s; and therefore it is needless to quote from him: Berkeley was better acquainted with the principles of the Newtonian philosophy, as well as an abler mathematician, than either of these pupils of the ancients; and being likewise a man who on all subjects thought for himself, it may be worth while to lay before our readers a short abstract of his reasoning respecting the origin of motion. His words are: “Totum id quod novimus, cui nomen *corpus* indidimus, nihil in se continet quod motus principium seu causa efficiens esse possit. *Vis, gravitas, attractio*, et hujusmodi voces, utiles sunt ad ratiocinia et computationes de motu et corporibus motis; sed non ad intelligendam simplicem ipsius motus naturam, vel ad qualitates totidem distinctas designandas. Attractionem certe quod attinet, patet illam ab Newtono adhiberi, non tanquam qualitatem veram et physicam, sed solummodo ut hypothesein mathematicam. Quin et Leibnitius, nism elementarem seu sollicitationem ab impetu distinguens, fatetur illa entia non re ipsa inveniri in rerum natura, sed abstractione faciendâ esse. Similis ratio est compositionis et resolutionis virium quarumcunque directarum in quascunque obliquas, per diagonalem et latere parallelogrammi. Hæc mechanices et computationi inserviunt: sed aliud est computationi et demonstrationibus mathematicis inservire, aliud rerum naturam exhibere. Revera corpus æque perseverat in utrovis statu, vel motus vel quietis. Ista vero perseverantia non magis dicenda est actio corporis, quam existentia ejusdem actio diceretur. Cæterum resistantiam, quam experimur in sistendo corpore moto, ejus actionem esse fingimus vana specie delusi. Revera enim ista resistantia quam sentimus, passio est in nobis, neque arguit corpus agere, sed nos pati: constat utique nos idem passuros fuisse, sive corpus illud a se moveatur, sive ab alio principio impellatur.—Actio et reactio dicuntur esse in corporibus: nec incommode ad demonstrationes mechanicas. Sed cavendum, ne propterea suppo-

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be admitted, (and we see not (x) why it should be called in question), it can be considered only as an instrument employed by Divine Wisdom, as a chizel or a saw is employed by the wisdom of the mechanic.

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This theory not inconsistent with the principle of Newton.

Nor let it be imagined, that this ancient theory of motion is in any degree inconsistent with the mathematical principles of Sir Isaac Newton's astronomy, or with the calculations raised from those principles. Having founded his astronomy on analogy between the phenomena of projectile and planetary motions, he assigned the same or similar forces existing in nature as the efficient causes of both. And indeed, both in the act of deriving his principles from the projectile phenomena, and afterwards for the purpose of applying them to the planetary, it was necessary to analyze the elliptical motion of the heavenly bodies into a compound of two simple motions in right lines, produced by the action of these different forces; and this might also be useful for the purposes of teaching and demonstration, just as we find it necessary, in all parts of science, to separate what in nature is inseparable, for the convenience and assistance of the understanding. The planetary motions, however, are very probably simple and uncompounded, for no experiments can be

N^o 214.

tried in those distant regions; and the astronomy of Newton, which is only the application of his mathematical principles to their mensuration from their analogy to projectile motions, does not at all require that the forces of gravitation and projection be assigned as their real existent causes (y). It is sufficient for the analogy, on which the whole philosophy is founded, that the phenomena of motion are known from experiments and observations to be the same in both instances; that the principles or general laws mathematically established from the forces of the one are transferred to the phenomena of the other; and that the proofs and operations deduced from these principles in the latter case, are confirmed by facts and experience, the first and final test of truth.*

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CHAP. VI. Of NUMBER.

"AMONGST all the ideas that we have, as there is none (says Mr Locke†) suggested to the mind by an idea, more ways, so there is none more simple than that of UNITY or one. It has no shadow of variety or composition in it. Every object our senses are employed about, every idea in our understandings, every thought of our minds, brings this idea along with it: and there-

* Tatham's Chart and Scale of Truth.

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Unity, as cannot
† Essay, Book ii. chap. 16.

supponamus virtutem aliquam realem, quæ motus causa five principium sit, esse in iis. Etenim voces illæ eodem modo intelligendæ sunt ac vox *attractio*: et quemadmodum hæc est hypothesis solummodo mathematica, non autem qualitas physica; idem etiam de illis intelligi debet, et ob eandem rationem.

"Auferantur ex idea corporis extensio, soliditas, figura, remanebit nihil. Sed qualitates istæ sunt ad motum indifferentes, nec in se quidquam habent, quod motus principium dici possit. Hoc ex ipsis ideis nostris perspicuum est. Si igitur voce *corpus* significatur id quod concipimus, plane constat inde non peti posse principium motus: pars scilicet nulla aut attributum illius causa efficiens vera est, quæ motum producat. Vocem autem proferre, et nihil concipere, id demum indignum esset philosopho.

"Præter res corporeas, alterum est genus rerum cogitantium: in iis autem potentiam inesse corpora movendi, propria experientia didicimus, quando quidem anima nostra pro lubitu possit ciere et sistere membrorum motus, quacunque tandem ratione id fiat. Hoc certe constat, corpora moveri ad nutum animæ, eamque proinde haud inepte dici posse principium motus; particulare quidem et subordinatum, quodque ipsum dependeat, a primo et universali principio.

"Ex dictis manifestum est eos qui vim activam, actionem, motus principium, in corporibus revera inesse affirmant, sententiam nulla experientia fundatam amplecti, eamque terminis obscuris et generalibus adstruere, nec quid sibi velint satis intelligere. E contrario, qui mentem esse principium motus volunt, sententiam propria experientia munitam præferunt, hominumque omni ævo doctissimorum suffragiis comprobata.

"Primus Anaxagoras τὸν πρῶτον introduxit, qui motum inertis materiæ imprimeret: quam quidem sententiam probat etiam Aristoteles, pluribusque confirmat, aperte pronuncians primum movens esse immobile, indivisibile, et nullum habens magnitudinem. Dicere autem, omne motivum esse mobile, recte animadvertit idem esse ac si quis diceret, omne ædificativum esse ædificabile. Plato insuper in Timæo tradit machinam hanc corpoream, seu mundum visibilem, agitari et animari a mente, quæ sensum omnem fugiat. Et Newtonus passim nec obscure innuit, non solummodo motum ab initio a numine profectum esse, verum adhuc systema mundanum ab eodem actu moveri. Hoc sacris literis consonum est: hoc scholasticorum calculo comprobatur."

De Motu, passim.

(x) This we say upon the received opinion, that there are beings wholly incorporeal. The truth of the opinion itself will be considered in a subsequent chapter.

(y) Indeed Sir Isaac himself is very far from positively assigning them as the real causes of the phenomena. The purpose for which they were introduced into his philosophy he clearly explains in the following words: "Eadem ratione qua projectile vi gravitatis in orbem flecti posset et terram totam circumire, potest et luna, vel vi gravitatis, si modo gravis sit, vel alia quacunque vi qua in terram urgeatur, retrahi semper a cursu rectilineo terram versus et in orbem suum flecti: et absque tali vi luna in orbe suo retineri non potest. Hæc vis, si justo minor esset, non satis flecteret lunam a cursu rectilineo: si justo major, plus satis flecteret, ac de orbe terram versus deduceret. Requiritur quippe ut sit *justæ magnitudinis*: et mathematicorum est invenire vim, qua corpus in dato quovis orbe data cum velocitate accurate retineri possit; et vicissim invenire viam curvilineam, in quam corpus e dato quovis loco data cum velocitate egressum data vi flectatur." — *Principia Mathem.* Def. V.

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therefore it is the most intimate to our thoughts, as well as it is, in its agreement to all other things, the most universal idea we have; or number applies itself to men, angels, actions, thoughts, every thing that either doth exist or can be imagined. "He seems likewise to be of opinion that we have the idea of *unity* before that of *many*; and that it is by repeating the simple idea of unity in our own minds that we come by the *complex ideas* of *two*, *three*, &c." In this opinion he is joined by Pere Buffier*; who observes that it is impossible to explain the nature of *unity*, because it is the most simple idea, and that which perhaps *first* occurred to the mind.

That *unity* is a simple idea, must be granted; but it certainly did not first occur to the mind, nor can it be abstracted from all individuals, and apprehended in Locke's sense of the word as a *general idea*. Let any man look into his own mind, and then say whether he has a general idea of *one* or *unity* as abstracted from every individual object mental and corporeal. In particular, when he thinks he has completely abstracted it from body and mind, sensations, ideas, actions, and passions, &c. let him be sure, before he pronounce it a general *abstract* idea, that he is not all the while contemplating the idea of its *name*, or of that numerical *figure* by which it is marked in the operations of arithmetic. Both these ideas are in themselves particular; and become general in their import, only as representing every individual object to which unity is in any sense applicable. But in the chapter of *abstraction*, we have said enough to convince every person capable of conviction that they are used as signs for whole classes of objects.

Instead of being an abstract general idea, *unity*, as the basis of number, is in fact nothing but a mere *relation*, which cannot be conceived without the related objects; and so far is it from being the *first* idea that occurred to the mind, that it is certainly the result of a comparison, made by the intellect, of two or more objects. The ideas which first occur to the mind are, beyond all doubt, those which are called *ideas of sensation*; and many such ideas every child receives before he is capable of comparing objects and forming to himself notions of number. *Unity*, or the idea of *one*, is indeed the element of the science of *arithmetic*, just as a mathematical *point* is the element of the science of *geometry*; but accurate notions of these elements are, in the progress of knowledge, subsequent to ideas of *many* and of *surfaces*. There is reason to believe that persons totally illiterate have no notion at all of *mathematical points*; and we think it possible to conceive an intelligent and conscious being in such a situation as that he could not acquire a notion of *unity* or *one*. Were a child never to see or feel two objects of the *same kind*, we doubt if he would think of numbering them, or of making such a comparison of the one with the other as would suggest to his mind the relations of *one* and *two*; for these relations imply both a sameness and a difference of the objects beyond the power of a child to ascertain. The difference indeed would be perceptible to the senses, but the senses would perceive no sameness or agreement. A guinea, a shilling, and a ball of lead, impress upon the mind different sensations; and there-

fore a child undoubtedly distinguishes these objects from one another: but what could make him derive from them his first idea of the relation of number? A guinea, a shilling, and a ball of lead, are not *one*, *two*, *three*, in any sense which a child can comprehend. To be convinced of this, let any man throw a guinea, a shilling, and a ball of lead upon a table, and ask a *clown* what is their number. From being accustomed to retail the *names* of number as signs, without affixing to them any idea of the things signified, he will probably answer with quickness *three*, or perhaps *one*, *two*, *three*: but if he be further asked in what *respect* they are *one*, *two*, *three*, we believe his answer will not be so ready: They are not *one*, *two*, *three* guineas, or *shillings*, or *balls of lead*. A philosopher knows them to be three pieces of the same first matter under different forms, and can therefore apply to them the relation of number with truth and propriety; but of the first matter a *clown* is entirely ignorant, and of course cannot call them *one*, *two*, *three*, in any sense which is at once true and to him intelligible.

To make it still more evident, that it is only by comparing together things of the *same kind* that our *first* ideas of unity and number are formed, let us suppose no created being to have hitherto existed except the animated and intelligent globe mentioned in the last chapter, and we think it will be granted that such a being in solitude could never acquire the idea of *unity*. Let us next suppose a *cubical* body to be created and exhibited to the senses of this spherical man; the consequence would be a *sensation* or feeling entirely new: but that feeling would not be of *unity*; for, as the author of *Ancient Metaphysics* has somewhere well observed, unity is no object of sensation. The sensation would be of colour, hardness, softness, roughness or smoothness, &c. for beyond these the empire of the senses does not reach. Again, let another body be created of a colour and figure totally different from the colour and figure of the cube, and the spherical man would then experience new sensations having no agreement with those which he had formerly felt. These different kinds of sensations might be compared together; but the result of the comparison would not be the ideas which are denoted by the words *one* and *two*, but merely that which is expressed by *difference* or *dissimilarity*. Were another cube, however, of exactly the same size and colour with the former to be brought into existence, and both to be at once presented to the view of the spherical man, the rudiments of the idea of number would then be generated in his mind, because he could not but perceive the cubes to be in one respect different and in another the same; different as being distinct from each other, and agreeing in their effects upon the organs of sensation.

It appears, therefore, that mankind must have made some progress in classing things according to their genera and species, before they acquired any correct ideas of the relation of number, or thought of using numerical names or figures as general and discriminating signs: for we say *one*, *two*, *three*, &c. only with respect to the species or genus of which each of the things denoted by these numbers is an individual; and if there be any thing which has no genus or species, neither number nor unity can, in the original sense of

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the words, be predicated of it (z). We say indeed that there is *one* God; but perhaps we do not always attend to the meaning of the expression. Language was formed to answer the common purposes of life; and those purposes are best answered by denoting individuals by the name of the species or genus to which they belong: but *God* belongs to no species or genus, unless he be said improperly (A) to be of the universal genus of *Being*; and therefore the true meaning of the word *one*, when joined to the verb *is*, and transferred from the creature to the Creator, in such a sentence as—"there *is one* God"—seems to be nothing more than an affirmation that God exists, and that to him the relation of number cannot be applied. In a word, *unity* and *number* are merely relations between the individuals of the same species or genus of being; and men acquire ideas of these relations at the same time and by the same means that they are led to class things into species and genera. As to the processes of addition and subtraction, and the various purposes to which number is applied, these things belong to the science of arithmetic, and fall not under the province of the metaphysician, whose sole object is to ascertain the real nature and causes of things. It may, however, be worth while to observe, that Locke, whose notions of number seem to have been different from ours, owns, that a man can hardly have any ideas of numbers of which his language does not furnish him with names. But if units were either real things, or even positive ideas, we see not how *names* could be necessary to their existence; whereas, if they be nothing more than mere relations, it is obvious that they cannot be conceived but as relative either to beings actually existing, or to names which are the signs of actual beings.

CHAP. VII. Of TIME.

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Time, a
mode of du-
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WHEN St Augustine was asked what time is? he replied, "*Si non roges, intelligo.*" An answer from which it may be inferred, that he thought the nature of *time* could not be explained by a logical definition. *Time* and *eternity* are commonly considered as the two modes of *duration*; and if duration be taken in what Locke thinks its true and original sense, to denote permanence of existence with a kind of resistance to any destructive force, the distinction seems to be sufficiently proper. It is indeed the best that we can make or compre-

hend; for *duration*, *time*, and *eternity*, are subjects Of Time. which have perplexed philosophical minds in all ages, and of which if we have adequate notions, it is very difficult to express these notions in language. Instead of attempting it by previous definitions, the method in which the ancients generally began their inquiries, we shall pursue the better course of induction recommended by Lord Bacon, and endeavour to show by what means we acquire the notion of that mode of duration which is called *time* in contradistinction to *eternity*. We begin with time; because we ourselves exist in it, and it is in some sense familiar to us. If we be able to trace our notions of this mode of duration to their source, we may then give a definition of it founded on fact and universal experience, and afterwards proceed to consider the other mode in conjunction with infinity, to which it is nearly allied.

It has been already observed (see n^o 93 of this article), that every man, while awake, has a train of sensations and ideas constantly passing through his mind, in such a manner as that the one succeeds the other in a regular order. It is not possible, either, by detaining in the mind one idea to the exclusion of all others, to stop the course of this succession entirely; or, by hurrying some ideas off the stage, and calling others in their place, to quicken its progress beyond a certain degree. One man indeed has naturally a quicker succession of ideas than another; and all men can, by great exertions, accelerate or retard in a small degree the natural flow of their thoughts. A studious man lays hold, as it were, of a particular idea, which he wishes to contemplate, and detains it in the imagination, to the exclusion of all others; a man of wit calls remote ideas into view with a rapidity of which a cool and phlegmatic reasoner can form no conception; and a forcible *sensation* takes full possession of the mind, to the exclusion of all *ideas* whatever. Whilst the attention is wholly occupied by one idea, or by one sensation, the mind has no notion whatever of time; and were it possible to detain such idea or sensation alone in the mind till the hand of a clock should move from the number of one hour to that of another, the hour, as marked on the dial-plate and measured by the motion of the hand, would appear but as one instant absolutely void of duration. For the truth of this assertion we appeal to the experience of our readers. Such of them as have ever been engaged in deep study must often have had their attention

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(z) We are happy to find our notions on this subject confirmed by an authority so respectable as that of Professor Stewart. "Without the power of attending separately to things which our senses present to us in a state of union, we never (says this able writer) could have had any idea of *number*: for before we can consider different objects as forming a multitude, it is necessary that we should be able to apply to all of them one common name; or, in other words, that we should reduce them all to the same genus. The various objects, for example, animate and inanimate, which are at this moment before me, I may class and number in a variety of different ways, according to the view of them that I choose to take. I may reckon successively the number of sheep, of cows, of horses, of elms, of oaks, of beeches; or I may first reckon the number of animals, and then the number of trees; or, I may at once reckon the number of all the organized substances which my senses present to me. But whatever be the principle on which my classification proceeds, it is evident that the objects numbered together must be considered in those respects only in which they agree with each other; and that if I had no power of separating the combinations of sense, I never could have conceived them as forming a plurality." *Elements of the Philosophy of the Human Mind*, chap. iv.

(A) We say *improperly*, because beings which were *created* can have nothing in *common* with that being which is *self-existent*, and upon whose *will* and *power* all other things depend.

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attention so fixed upon one object, that large portions of time, as measured by the clock, have passed away wholly unheeded; and every man who has seen a very striking and uncommon object, must remember, that when the sensation was first impressed upon his mind, all other objects, ideas, and notions, and among the rest the notion of time, were for a while excluded.

No sensation, however, keeps possession of the whole mind after it has ceased to be new; nor can the most vigorous exertions long preserve any one idea from being driven off the stage by the succeeding train. Now this succession of ideas appearing and disappearing in their turns, is that which, when compared with the permanency of ourselves and other things, gives us our first and justest notion of time: for whilst we are thinking, or whilst a series of ideas is successively passing through our minds and vanishing, we know that we ourselves and the things around us exist; and this existence, or continuation of existence, commensurate with the train of our fleeting ideas, is what we call the *duration* of ourselves and the things around us.

We are aware that our first notions of time have been often said to be derived from *motion* as perceived by our senses in the objects around us. It is observed by Euclid, that "if there were no *motion*, there could be no sound, nor any sense of hearing." "He might have added (says the author of *Ancient Metaphysics*), nor any other perception of sense. Further, without motion there would have been no visible world, nor generation or production of any kind here below; and, among other things, *time* could have had no existence." All this is certainly true; but that corporeal motion, though the original source of all our ideas, is not that which *immediately* suggests to us the notion of time, will be readily granted by him who considers that motion itself is perceived by us only when it excites or accompanies a constant succession of perceptions and ideas. Motion, when equable and very slow, such as that of the hour-hand of a common watch, is not perceived by us in its course; nor can we discover that the thing has moved at all, till after we have been sensible of the lapse of a considerable portion of what is commonly called *time*; when we discover that the hand of the watch has changed its place with respect to other objects which we know to be fixed. The same is true of motion remarkably quick: "Let a cannon-ball (says Locke) pass through a room, and in its way take with it any limb or fleshy parts of a man; it is as clear as any demonstration can be, that it must strike successively the two sides of the room: it is also evident that it must touch one part of the flesh first, and another after, and so in succession: and yet I believe nobody who ever felt the pain of such a shot, or heard the blow against the two distant walls, could perceive any succession either in the pain or sound of so swift a stroke."

Of these two phenomena a satisfactory account may be easily given; from which we think it will at the same time be apparent, that the succession of the train of ideas in the mind is the measure and standard of all other successions. We know that the energy of the mind which reviews a train of sensible ideas is of the very same kind with that which attends to a series of passing sensations (see n° 69); and therefore it is natural to suppose that we can pay attention to sensations

and ideas passing with nearly equal velocities. But it has been shown, that every sensation remains in the mind or sensorium for a very short space after the object which excited it is taken away: whence it follows, that a body communicating to the organs of sense a series of similar impressions succeeding each other with remarkable rapidity, cannot excite a train of similar and distinct sensations; because the effects of the first and second impressions not having vanished when those of the third and fourth arrive, the whole train of effects must necessarily coalesce into one uniform sensation. This reasoning is confirmed by experience. Similar sounds succeeding each other at considerable intervals, are all distinctly perceived; and if the motion be accelerated gradually, it may be carried to a great degree of velocity before the sounds be confounded and coalesce into one. "Mr Herschel having, by means of a clock, produced sounds or clicking noises, which succeeded each other with such rapidity that the intervals between them were, as far as could be judged, the smallest possible, found that he could evidently distinguish one hundred and sixty of them in a second of time; but beyond that he could by no effort of attention distinguish one sound from another. The same philosopher tried another experiment on visible sensations. By means of the same handle and work of the clock, he caused a wheel in it to turn till it acquired the velocity of once in a second. He continued to increase the velocity, and observed it while revolving at the rate of twenty times round in thirteen seconds, and could still distinguish the teeth and spaces from each other; whence it appears (by a computation given at length), that he had two hundred and forty-six distinct visible sensations generated by equable motion in a second of time. The teeth of the wheel, he owns, were not so far visible as to show their shape distinctly, much less could they have been counted: but he very plainly distinguished the circumference to be divided into teeth and spaces; and he supposes that the same division might still have been seen though the motion had been a little faster, as far perhaps as two turns in a second, equal to three hundred and twenty sensations*." The reason that the division could not be seen whilst the wheel moved more rapidly than twice round in a second of time, was doubtless the continuance of that agitation in the brain from which each sensation proceeded, until a new impression caused a new agitation, which coalesced with the former and removed all distinction. Hence it is plain, that no external succession can be perceived which moves with a greater velocity than that of which the internal train of sensations and ideas is capable. On the other hand, an external succession which moves with less rapidity than that to which the internal flow of ideas may be reduced, either has not sufficient force to generate sensations at all, or the successive impressions from which the sensations proceed follow one another at such distances as to permit the natural train of ideas to intervene between them, and thus destroy the perception of the succession entirely.

To us, therefore, it seems evident, that the constant and regular succession of ideas in the mind of a waking man, is the measure and standard of all other successions; of which, if any one either exceeds the pace of which our ideas are capable, or falls short of

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* Watson's
Treatise on
Time.

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it, the sense of a constant and continued succession is lost, and we perceive it not but with certain intervals of rest between. So that it is not motion, but the constant train of ideas in our minds, that suggests to us our first notion of time; of which motion no otherwise gives us any conception, than as it causes in our minds a constant succession of sensations: and we have as clear a notion of time by attending to the train of ideas succeeding each other in our minds, as by a train of sensations excited by constant and perceptible motion.

* Essay on Truth.

That it is merely by comparing the permanent existence of things with the fleeting succession of ideas in our own minds that we acquire our notions of time, may perhaps be still more evident from the following narrative quoted by Dr Beattie *, from *L'Histoire de l'Academie Royal des Sciences pour l'annee 1719*. "A nobleman of Laufanne, as he was giving orders to a servant, suddenly lost his speech and all his senses. Different remedies were tried without effect. At last, after some chirurgical operations, at the end of six months, during all which time he had appeared to be in a deep sleep or deliquium, his speech and senses were suddenly restored. When he recovered, the servant to whom he had been giving orders when he was first seized with the distemper, happening to be in the room, he asked whether he had executed his commission, not being sensible, it seems, that any interval of time, except perhaps a very short one, had elapsed during his illness." If this story be true, here was a man, who, by the train of ideas vanishing at once from his mind, lost the perception of what was to others six months of time; and had all mankind been in his state, the same portion of time would have been irrecoverably lost even to the annals of chronology.

We are aware of an objection to any inference which may be drawn respecting the present question from the case of this nobleman. It may be said, that he had lost, together with the perception of time, the perception of every thing besides; and that, therefore, motion may still be the cause from which a waking man derives his notions of time. But in reply to this objection, we beg leave to ask, Whether if a ball had been put in motion on a table, and the nobleman had been told, that a body moved with the velocity of that ball would have been carried over so many thousand miles of distance during the time that he lay in a state of insensibility, he could from such information alone have formed any tolerable notion of the length of time in which he was insensible? He certainly could not, for want of a standard by which to measure the rapidity of the motion. He would, indeed, have known instantly that he had been insensible for a considerable length of time, because he had the evidence of former experience that a body carried by perceptible motion over a great extent of distance would have generated in his mind a vast train of successive sensations; but till he had attended this ball during part of its course, and compared with the permanency of other objects the series of sensations which it generated in his mind, he would not have been able to guess with any thing near to accuracy the length of time it would take to pass over a thousand miles.—The same insensibility of duration happens to every

man in sound sleep. From having notions of time, such as they are, formed in our minds, we never indeed suppose, however soundly we have slept, that the moment at which we awake in the morning is contiguous to that in which we fell asleep at night. The reason is obvious; every man has been awake whilst others were sleeping, and has known by experience, that if they had been awake likewise a train of ideas would have passed through their minds which must have suggested to them the notions of time. Most men, too, have been frequently awake whole nights, and have thus acquired a notion of time as going on incessantly, whether perceived by them or not; and this notion being closely associated with our ideas of night and morning, we inevitably suppose a portion of time to have elapsed between them, though unperceived by us in our sleep. But were a man to sleep without dreaming from Sunday night till Tuesday morning, and then to awake at his usual hour as marked on the clock, there are numberless instances on record to convince us, that he would not of himself suppose, nor perhaps be very easily persuaded, that more than one night had elapsed between his falling asleep and the moment at which he awoke.

It being thus evident, that our notion of time is suggested by that comparison which we inevitably make of the existence of things permanent with the train of ideas incessantly passing through our minds; we may now perhaps be able to answer the question, "What is time?" It must of necessity be one of three things, viz. either the ideal succession itself; a certain quality inherent in all objects; or merely the relation of co-existence between things that are permanent and the trains of fleeting ideas which succeed each other on the theatre of the imagination. It is not the first of these; for in every train of thought, the appearance of any one idea in the mind occupies no more of the extension of time, than a mathematical point occupies of the extension of distance. Ten thousand mathematical points added together would make no part of a line; and ten thousand ideas made to coalesce, if that were possible, would occupy no part of that mode of duration which is called *time*. A point is the boundary of a line, but no part of it: the appearance of an idea in the mind is instantaneous; and an instant is the boundary, but no part of time. Hence it follows, that were every thing instantaneous like ideas in a train, there could be no such thing as time, since nothing could be said to have in that sense of the word any duration. That time is not a quality inherent in all objects, is likewise plain; for we have seen, that were *ideas* as permanent as objects, the notion of time could never have been acquired. Succession, though it does not itself constitute time, is essential to its existence; and were all motion to cease, and the attention of men to be immoveably fixed upon one invariable object or cluster of objects, *time* would cease likewise. It remains, therefore, that time can be nothing else than the relation of co-existence apprehended between things that are permanent and those trains of fleeting ideas which incessantly succeed each other on the theatre of the imagination. Thus whilst a man is steadily looking at one object, which, from its being common, does not occupy his whole mind, he may be conscious of a thousand ideas starting up

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Time a mere relation of co-existence.

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Of Time. in his imagination, and each in its turn vanishing the instant in which it appeared. Every one of these ideas had an existence as well as the object at which he is looking; but the existence of each of them was instantaneous and in succession, whilst the existence of the external object is permanent. The object, therefore, as contrasted with the train of ideas, is said to endure or to exist in time, whilst each idea is destitute of duration, and exists in no time.

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Objections
answered.

To this theory some objections occur, which it will be incumbent upon us to obviate. It may be said, that though each idea considered by itself is instantaneous, and occupies no time; yet the whole train when taken together, without being compared with any thing external, is perceived to occupy a considerable portion of that mode of duration; and that, therefore, time itself must be something more than a mere relation between a fleeting succession of ideas and objects of more permanent existence. But how, we beg leave to ask, is the whole train perceived to occupy any portion of time? Is it not by being compared with our own existence? A man, whilst a train of ideas is passing through his mind, may be suddenly deprived of all his external senses, and then indeed it will be impossible for him to compare the fleeting existence of this internal succession with the more permanent existence of external things; but, whilst he thinks at all, he must be conscious of his *own* existence, and cannot avoid perceiving, that whilst his ideas pass in constant succession, each making an instantaneous appearance in his mind, he himself remains unchanged. Now, what is it that this perception suggests to the mind? Evidently nothing more than the relation of co-existence between a fleeting succession and a permanent object; for were it possible that the man could be deprived of memory as well as of his senses, and still have ideas succeeding each other in his mind, he would then think all objects equally fleeting; he would indeed be himself a mere succession of instantaneous distinct persons, and could have no notion whatever of time. His existence, though it should seem to endure half a century as estimated by others, must to himself appear to pass away like a flash of lightning.

It may be still further objected to our theory, that time is measured by motion; and that it seems very absurd to talk of measuring a relation, especially a mere *ideal* relation, by a real external thing. In answer to this objection, which at first sight appears formidable, we beg leave to observe, that all relations are equally ideal; and that yet many of them may be said to be measured by real external things, with as much propriety as time can be said to be measured by motion. When a man wishes to ascertain the relation of quantity which one body bears to another, though he knows that such a relation has no other than an ideal existence, and cannot be conceived but in conjunction with the related bodies, he applies to them successively some common standard; and having discovered the relation which each bears to that, he compares the one relation with the other, and thus ascertains the relation sought. Just so it is with respect to motion measuring time. That which to each individual constitutes real time, is the relation of co-existence between the fleeting succession of his own ideas and other

things of a more permanent nature. But a man has often occasion to ascertain the time of things external which fall not under the inspection of his senses; and in society all men have transactions with one another to be performed in some determinate portion of time, though there are not, perhaps, two men existing whose ordinary trains of thought flow with precisely the same rapidity. To remedy these inconveniences, it was necessary to invent some common standard, by means of which men might ascertain the duration of actions performed at a distance, and be able to keep appointments made with each other. The only standard proper for these purposes is such a constant and equable motion as has suggested a flux of perceptions common to all men in all ages and countries; and hence the motions of the heavenly bodies have been universally made use of for the common regulators of time. These motions, however, do not constitute real and natural time, any more than a foot or a yard applied to two distant bodies constitutes the relation of quantity which these bodies bear to each other. They are merely stated measures, to be differently applied according to the different purposes which we have in view.

Thus, if a man in Europe wishes to know what would to him have been the *real* and *natural* time of an action performed in the East Indies, he has only to be told, that it was co-existent, we shall suppose, with a diurnal revolution of the earth; and by comparing this common measure with his usual flow of thought, he can form some notion of the extent of that train of ideas, which, had he been present, would to him have been successively co-existent with the action in question. But when persons have an appointment to keep, this common measure of motion must be differently, or rather partially, applied. In such cases, it is no part of their intention to compare their own existence with that of the whole train of ideas which may pass in the mind of each; for the result of such a comparison, which alone constitutes true and natural time, would not be the same in perhaps any two men: but their purpose is, to compare their own permanent existence only with that train of sensations which shall be excited in the mind by the perceptible motion of the sun, or any other body fixed upon which moves equably; and such a train must consist of an equal number of instants in all men. Neither the sun, nor the hour-hand of a common watch, moves with such apparent rapidity as to keep pace with the internal flow of thought of which the most phlegmatic man is conscious. That these bodies move at all, is known only by their visible change of place during the lapse of a considerable portion of real time; and as there is in their course a certain number of places distinctly marked, to which alone it is agreed that the attention is to be turned, it is impossible that of time so computed two men can have different notions. Such time, however, is but partial; and the method of ascertaining it, when compared with that by which we ascertain real time, has a striking resemblance to that by which we ascertain the relation of partial quantity between two distant bodies. When it is our purpose to ascertain the relation of real quantity which one body bears to another, we apply the common standard to each in every dimension of length, breadth,

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²¹⁵ **Of Time.** breadth, and depth ; but when we have no other view than to ascertain the relation of length which the one bears to the other, we apply the common standard to each in that dimension only. Just so it is with regard to real and partial time. When an individual wishes to ascertain what would to him have been the duration of any action which he did not see performed, he applies the common standard to the existence of that action, and to the usual flow of his own thoughts ; but when two men talk of the duration of any action, or agree to meet on such a day, they compare the existence of the action, or the distance intervening between the present moment and the day of meeting, only with that partial train of sensations which by the common standard is generated in an equal number, and in the same order, in the minds of both.

²¹⁵ Time must have had a beginning. It will be said, that if time be nothing more than a mere relation subsisting between trains of ideas or other fleeting objects, and things of a more permanent existence ; and if the universe had a beginning ; either time must have had a beginning likewise, or the Deity cannot be immutable. We allow the force of the argument ; but instead of an objection, we consider it as a confirmation of the truth of our theory. The Deity, who is immutable, exists not in time, but in eternity ; and that these, though from the poverty of language they are both called modes of duration, are yet very different from each other, we shall endeavour to prove in the next chapter.

CHAP. VIII. Of INFINITY and ETERNITY.

²¹⁶ Why we treat of infinity and eternity among the adjuncts of body. As corporeal substance is certainly not infinite, and as the present material system has in itself every evidence of its not being eternal, it may seem strange, perhaps, to the reader, that we should treat of infinity and eternity among the adjuncts of body. But in modern metaphysics these words are used in a vague sense to denote the extent of space and time ; and in this chapter it is our intention to do little more than ascertain their meaning, and to show, in opposition to some celebrated names, of what subjects they may not be predicated. There is a mathematical and a metaphysical infinity, which, though often confounded, ought to be kept distinct. In mathematics, extension is said to be divisible *ad infinitum*, and number is sometimes considered as infinite : but in metaphysics these modes of expression are extremely improper. A positive and metaphysical infinite is that which has no limits, and to which no addition can be made ; but it is obvious that there is no number which may not be enlarged, nor any positive idea of extension which has not limits, and which may not be either increased or diminished. The infinity of the mathematician is termed *infinity in power*, and that of the metaphysician *absolute infinity*. The first consists in this, that a being, however great or small it be supposed, may still be conceived to possess more greatness or minuteness than we can form an idea of, even after the utmost stretch of human thought. Thus when it is said that all exten-

sion as such is infinitely divisible, it is not meant that every extended substance contains an infinite number of *real parts* ; for then the parts of an inch would be equal to those of a league : but the meaning is, that in ideal extension we can never reach the end of ideal division and subdivision. In like manner, when it is said that number is infinite, the meaning is not that any positive number is without limits, or the possibility of increase, but that we might go on for ever, adding unit to unit, without approaching nearer to the end of the process. If, therefore, the mathematician would speak properly, and without the affectation of paradox, he ought to say that all extension as such is *indefinitely* divisible, and that unit might be added to unit without end ; but these phrases suggest notions very different from that of a metaphysical infinite, which is something positive to which nothing can be added. (B)

²¹⁷ That there is something positively infinite, has been very seldom questioned ; but it has been warmly disputed among metaphysicians what subjects are infinite. Dr Clarke and his adherents have contended that space and time are real things ; that they are both of necessary existence ; that the former impresses us with the idea of its infinity, and that the latter is positively eternal. “ Time and space (says the Doctor*) are the *sine qua non* of all other things, and of all other ideas. To suppose either of them *finite*, is an express contradiction in the idea itself. No man does or can possibly imagine either of them to be finite ; but only either by *non-attention* or by *choice* he attends perhaps to part of his idea, and forbears attending to the remainder. They who suppose space to be nothing but a relation between two bodies are guilty of the absurdity of supposing that which is *nothing* to have *real qualities* : For the space which is between two bodies is always unalterably just what it was, and has the very same dimensions, quantity, and figure, whether these or any other bodies be there or any where else, or not at all. Just as time or duration is the same, whether you turn your hour-glass or no, or whether the sun moves or stands still, or whether there was or was not any sun, or any material world at all. To set bounds to space is to suppose it bounded by something which itself takes up space, and that’s a contradiction ; or else that it is bounded by nothing, which is another contradiction. To suppose space removed, destroyed, or taken away, amounts to the absurd supposition of removing a thing away from itself ; that is, if in your imagination you annihilate the whole of infinite space, the whole of infinite space will still remain ; and if you annihilate any part of it, that part will still necessarily remain, as appears by the unmoved situation of the rest ; and to suppose it divided or divisible amounts to the same contradiction.”

The absurdity of considering space as a real external thing has been already evinced in chap. 4th, p. 549, where it was shown how we acquire the notion, and what kind of notion it is. Space, as was there observed, may be conceived either as the mere absence and possibility of body ; or as ideal extension, united to, and inhering in, an ideal substratum. Taken in the former sense, it is an object of pure intellect ; in the latter, it

(B) *Cυ γαρ ου μὴδιν ἐξω ἀλλ’ οὐ αὖτε ἐξω ἐστὶ, τοῦτο ἀπειρον ἐστὶ.* *Arist. Phys. Auscult. Lib. 9. cap. 9. page 492, Tom. I. Oper.*

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and Eter-
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Neither
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* Dr Law's
Inquiry into
the Ideas of
Space, Time,
Immensities,
and Eter-
nity. See al-
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acute writ-
ter's transla-
tion of
King's Ori-
gin of Evil.

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and Eter-
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The usual
reply to the
foregoing
reasoning
shown

is an *idea* or *form* in the imagination. That the absence of body or matter is the *sine qua non* of all other things, and all other ideas, Dr Clarke was not disposed to affirm, when he made the divine substance, to pervade every material atom in the universe: and to talk of the absence of body being infinite is a palpable contradiction, unless Berkeley's doctrine be true, that the material world has no existence. To say that the *possibility* of matter is infinite, is to use language which has no other meaning than that, however far the material world be on all sides extended, its extension may still be conceived greater and greater *ad infinitum*. This is a position which no philosopher ancient or modern has ever denied; but it is so far from implying that we have a positive idea of the infinity of the material world, or of any adjunct of the material world, that it is absolutely inconsistent with such infinity. Whatever is capable of perpetual increase must certainly have limits, and every new addition is the limit of that to which the addition was made.

Taken in the second acceptation as an ideal extension united with an ideal *substratum*, space is so far from being infinite in any sense of the word, that we will venture to assert no man ever contemplated such a *form* in his own imagination, without conceiving it to be bounded. Of this, at least, we are certain, that when we have attempted to frame a positive idea of pure space, it has not been in our power to divest that idea of limits. Those who can frame in their minds real and positive ideas wholly abstracted from every individual object, may indeed perform in this way many feats above our abilities; but as we possess no such powers of abstraction, every thing which we can call an idea is limited in the same manner that the object itself is limited from which the idea was derived.— Thus, the largest expansion that ever we beheld is the concave hemisphere; and when we try to form the largest positive idea of pure space, all that we can do is to figure to ourselves that concave empty of body. We may, indeed, suppose its diameter to be either a million or ten thousand millions of miles; and we may go on enlarging it *ad infinitum*: but when we return from this process of intellect to the contemplation of the ideal forms in the imagination, none of these forms appear to us larger or more extended than the hemisphere, which is the object of sense, and they all appear to be bounded, and bounded in the very same way.

With respect to the eternity of time, we think Dr Clarke equally mistaken as with respect to the infinity of space. Of time, indeed, we cannot properly speaking have any *idea* or mental *form*. Time, as we have seen, is a mere relation, and is in itself the creature of the mind which has no external *idiatum*. It is suggested, however, by the fleeting succession of our ideas, compared with the more permanent existence of other objects; and therefore succession is essential to it. But nothing which has parts, whether co-existent or in succession, can be positively infinite. For, "in an infinite series of successive generations of men, for instance, there will be several infinities that are parts of one another, and by consequence one greater than another: which (as has been well argued *) is an express contradiction, since the greater must necessarily bound the less, and exceed its limits by so much as it is greater than it; that is, must make it not infinite.

Infinite generations contain an infinitely greater infinity of particular men. An infinite number of men must have twice as many hands, and ten times as many fingers, and so on. Infinite time has an infinity of ages; these a much greater infinity of years, days, hours, &c. Space likewise (according to Dr Clarke) has three dimensions, all infinite. It must, therefore, contain an infinity of surfaces, an infinitely greater infinity of lines, and a still infinitely greater infinity of physical points. The case is the same in number itself, which, if we suppose it to contain an absolute infinity of thousands (and we may as well do that as imagine it to comprehend an infinity of units), it will contain ten times as many hundreds, fifty times as many scores, and so on. All this is only the *indeterminateness* of number, which we in vain attempt to turn into a positive infinite with which it is totally incompatible. For let us add *one* to any of these infinite series of generations, ages, lines, or numbers, which we know to be always in our power, and if it was absolutely infinite before, here is one more than infinite. If it only becomes infinite now, then one finite added to another finite makes infinity. If it be no larger after the addition than it was before, then one part added to another adds nothing; all which are absurdities. The same will appear, if we subtract a part from this supposed absolute infinite, which may be done in any of the formentioned subjects, as well as in every thing which admits of parts, or may be taken in pieces by the mind."

To this kind of reasoning Dr Clarke replies as follows: "To endeavour to prove that there cannot possibly be any such thing as *infinite time* or *space*, from the impossibility of an addition of finite parts ever composing or exhausting an infinite; or from the imaginary inequality of the number of years, days, and hours, that would be contained in the one; or of the miles, yards, and feet, that would be contained in the other, is supposing infinities to be made up of numbers of finites; that is, it is supposing finite quantities to be *aliquot* or *constituent* parts of infinite, when indeed they are not so, but do all *equally*, whether *great* or *small*, whether *many* or *few*, bear the very same proportion to an infinite, as mathematical points do to a line, or lines to a superficies, or as moments do to time, that is, none at all. No given number or quantity can be any *aliquot* or *constituent* part of infinite, or be compared at all with it, or bear any kind of proportion to it, or be the foundation of any argument in any question concerning it."

If it be indeed true, and it is that for which we contend, that no given number or quantity can be any aliquot or constituent part of infinite, or be compared at all with it; then it undeniably follows, not that miles, yards, and feet, are no constituent parts of space; or years, days, and hours, constituent parts of time; but that space and time cannot possibly be positive infinities. This, we say, follows undeniably: for nothing is more evident, than that all quantities of the same kind, from the largest to the least, bear a certain proportion to each other; and upon the supposition that space is a real extended thing, miles, yards, and feet are included in it, and bear to it the relation of parts to a whole. The same is true of time, days, and hours. To affirm (for no proof is offered), that

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all finite quantities, whether great or small, whether many or few, do equally bear the very same proportion to an infinite, as mathematical points do to a line, or as moments do to time, is plainly to beg the question—"that *space* considered as a real extended thing is infinite;" and to beg it, too, in opposition to the common sense and reason of mankind. Mathematical points we all know to be nothing real, but merely negations of extension; but supposing *space* to be something real and extended, can any man persuade himself that a mile or a million of miles of this *space* is likewise a mere negation of extension? With him who can bring himself to this persuasion, we pretend not to argue. He is possessed of faculties, whether true or false, of which we are destitute.

That finite quantities, whether great or small, do all equally bear the same proportion to an infinite in power, is indeed true; but it is no great discovery: for such an infinite, as we have seen, is nothing but the continued possibility of repeating the same mental process of addition or multiplication; and he who can go on for ever adding, in his own imagination, foot to foot, or hour to hour, will find it equally easy to add, in the same manner, league to league, or age to age. If he can perform the one operation, he must likewise have power to perform the other; and he cannot but perceive that it is as impossible to come to an end of adding league to league, or age to age, as of adding foot to foot, or hour to hour; but then he must know that these leagues, feet, ages, and hours, are not real external things, but mere ideas and notions in his mind. If such powers of ideal multiplication and addition be what Dr Clarke means by the ideas of *space* and time, it is indeed a contradiction to suppose either of them limited; for that is to suppose our powers different from what we know them to be by consciousness and experience. But to confound powers with the objects of those powers, is certainly very inaccurate; and to suppose, because we can go on for ever adding one portion of ideal *space* or time to another, that therefore our ideas of *space* and time are in themselves positively infinite, is a contradiction: for to an idea positively infinite, it is obvious that nothing can be added. Either, therefore, *space* and time do not impress us with the ideas of their positive infinity; or we cannot have the power of adding league to league, and age to age, without end.

"But (says the Doctor), to suppose *space* removed, destroyed, or taken wholly away, amounts to the absurd supposition of removing a thing from itself; that is, if in your imagination you remove the whole of *space*, the whole of *space* will still remain." True, every man has ideas of *space* treasured up in his imagination, which the sound of the very word *space* will at all times bring into his immediate view; and whilst he has such ideas, it is impossible that he should not have them; which is all the mystery of the matter, and amounts to nothing more than that a thing cannot be and not be at the same instant. When the Doctor affirms, that if "you annihilate any part of *space*, that part will necessarily remain, as appears by the unmoved situation of the rest", we are not certain that we perfectly understand him. A man may surely think of a cubical inch without thinking of a foot or a yard;

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and he may suppose the inch taken away from the foot or the yard, and these ideal quantities so much lessened by the subtraction. But if the Doctor be here again confounding the powers of the mind with the positive ideas of *space*, the sentence when explained will be seen to contain nothing to his purpose. Every man has the power of contemplating in idea millions of miles, and millions of ages, and of adding mile to mile, and age to age, without end; and if he try to deprive himself of any part of this power, or to fix a limit to the mental process of addition, he will find that in spite of himself his imagination will ramble beyond the limit assigned, and that he has attempted an impossibility. This, however, is so far from being a proof that his ideas of *space* and time are positively infinite, that, as we have already observed, it is a proof of the contrary.

But (say this great man and his followers) "space and time are the *sine qua non* of all other things and all other ideas. The supposal of the existence of any thing whatever includes necessarily a presupposition of the existence of *space* and time;" and therefore, if there be any thing infinite and eternal, *space* and time must likewise be so.

To every corporeal substance, and every idea of such substance, *space* and time are indeed necessary: for every body has extension and duration; and every idea of a particular body, being nothing but a secondary perception in the imagination or memory, must have the same relation to imaginary extension, that the object from which it was derived has to extension which is real. Every idea, too, which remains in the imagination whilst a train of other ideas passes successively in view, or whilst external things are perceived to change, has real time. But will any man say that consciousness, our notion of power, our acts of willing, or even tastes, sounds, and smells, are extended, or that the supposal of their existence necessarily implies a presupposition of the existence of *space*? We acquire our ideas of extension and *space* by means of our senses of touch and sight; and we learn from experience, that things external and extended are the causes of our sensations of taste, sound, and smell. The effects are in our minds closely associated with the ideas of their causes; and it is not perhaps easy to think of a particular sound, taste, or smell, without at the same time thinking of the object by which it was at first excited in the mind: but had we been originally formed with the powers of consciousness, thinking, and willing, and with no other senses than those of tasting, smelling, and hearing, it is obvious that we never could have had the idea of *space*; and therefore, that idea cannot possibly be necessary to the presupposition of every thing else. To consciousness, thinking, and willing, *space* is so far from being necessary, that we cannot perceive any the most distant relation between them. It is not more difficult to conceive a part greater than the whole, than it is to conceive an ell of consciousness, of thought, or of will; nor is it in the power of any man to make *space* and sweetness coalesce in his mind so as to form of the two simple ideas one complex conception. The very reverse is the case with respect to the objects of sight and touch. The idea of every thing which we see and handle necessarily

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Space and
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to time.

ly coalesces in the mind with the idea of space, nor can we possibly separate the one from the other; but the things which we see and handle are neither infinite nor capable of infinity.

With respect to time, the same observations will be found to be just as with respect to space. Whatever is liable to change, exists in time and cannot be eternal; but if there be any being immutable, and who views at once all things which to us are past, present, and to come, the existence of that being is not commensurable with time. That such a being is possible no man can doubt, who reflects, that if we had one permanent idea invariably in the mind, we should never have acquired the *notion* of succession or of time; and that if there were *actually* no change in nature there could not possibly in nature be any such *thing as time*. Every man, therefore, who can conceive existence without change, must be convinced, that "the supposal of the existence of any thing whatever does *not* necessarily include the presupposition of the existence of time; and that there may be an eternity distinct from time, as well as an infinity distinct from space; nay that nothing which is properly infinite and eternal can possibly occupy either space or time.

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Infinity and
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are.

If it be asked, what kind of infinity and eternity they are which have no relation to space and time? Cudworth, treading in the footsteps of the ancients, has long ago answered, that they are "absolute perfection, and necessary existence. For (says he), *infinite understanding and knowledge* is nothing else but *perfect knowledge*, which hath in it no defect or mixture of ignorance, but knows whatsoever is knowable. In like manner, *infinite power* is nothing else but *perfect power*, which hath in it no defect or mixture of impotency—a power which can do every thing which is possible or conceivable. Lastly, *infinity of duration, or eternity*, is really nothing else but *perfection*, as including in it *necessary existence and immutability*; so that it is a contradiction to suppose such a being to have had a beginning, to cease to be, or to suffer or be affected by any change whatever. And because infinity is perfection, therefore nothing which includes in its idea or essence any thing of *imperfection*, as every positive idea of number, corporeal magnitude, and suc-

cessive duration evidently does, can be truly and properly infinite." *

It must indeed be confessed, that the idea of succession so insinuates itself into our usual ideas of existence, and is so closely connected with the existence of all finite beings, that we find it extremely difficult to imagine the eternal existence of God, any otherwise than as an eternally continued series or succession. Our constant conversation with material objects, and the associations thence arising, make it almost impossible for us to consider things abstracted from time and space; yet we have the evidence of experience and consciousness, that an idea may be conceived without relation to space and time, and that space and time cannot be made to coalesce with some of our notions. The same must be true with respect to infinity and eternity; for we have seen that neither space, time, nor any thing else which consists of parts, whether continuous or successive, can be supposed to be positively infinite, as the supposition implies the most palpable contradiction. But that there may be perfect power, perfect knowledge, and permanent invariable existence, is so far from implying any contradiction, that even we, whose faculties are so very narrow, can yet make some advances towards the conception of such perfections. Thus, every man of common understanding knows that some things are in themselves possible, and others impossible, to be performed by any power. Of these possibilities and impossibilities a philosopher knows more than an illiterate man; and one philosopher knows more than another. An intellect more perfect knows more of them than any man; and that intellect which knows them all must be absolutely perfect, and incapable of improvement, because it knows every thing which is to be known. The same is true of perfect power:—but we shall treat of real infinity and eternity more at large when we come to demonstrate the being and attributes of God. At present it is sufficient to have shown, that nothing can be positively infinite but a being absolutely perfect; which never was not, which can produce all things possible and conceivable, and upon which all other things must depend.

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and
Eternity.

* *Intellectual System.*

PART III. OF MINDS AND THEIR POWERS.

CHAP. I. Of MIND in GENERAL.

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Mind distinguished
from body.

THE science of metaphysics comprehends every thing into the existence, nature, or causes, of which any inquiry may be made. But all things of which we have any notion or idea may be divided into mind and body, with their various powers, qualities, and adjuncts. By body is meant that which is solid, extended, inert, and divisible; and its several adjuncts are space, motion, number, and time. The only mind with which we are *intimately* acquainted is our own; and we know that it is possessed of the powers of sensation, perception, retention, consciousness, reflection, reason, and will. These are totally different from extension, solidity, divisibility, and motion; and there-

fore it is proper to distinguish the being of which they are powers by another name than that of body.

Of bodies there are various kinds possessing various sensible qualities; and from analogy it is reasonable to conclude, that there may be various classes of minds endowed with different kinds or degrees of power. For this indeed we have stronger evidence than that of analogy. Brute animals evidently possess the powers of perception and spontaneity with some degree of consciousness; but as they appear not to reflect upon their own conduct, or to have their actions influenced by motives, their minds are inferior to ours, though still perfectly distinct from mere extended, inert, and divisible substances. Mind, therefore, considered with respect to its powers, is evidently different from body considered with respect to its qualities. This is indeed

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Probably
minds of
different
orders.

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in general.

a truth which has seldom if ever been controverted; but it has been long and warmly disputed, Whether mind and body be not both composed of the same first matter?

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The absurd
hypothesis
of Hobbes
respecting
mind.

Hobbes supposed, that every material atom is endowed with the faculty of sensation(c); but that for want of memory each sensation is momentaneous, being instantly and wholly effaced as soon as its cause is removed. Though this hypothesis is too absurd to require a formal and laboured confutation, it may not be improper to observe, that, if it were true, the hairs of a man's head would feel extreme pain when pinched by the hot iron of the hair-dresser; and that the nails of his fingers would be severely tortured when under the operation of the knife or the rasp.

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Other ab-
surd hypo-
theses.

Others have supposed that each atom of matter has a *tendency towards* sensation and perception; and that when a sufficient number of these atoms are brought together in a certain order, the *united tendencies* produce the *actual* powers which distinguish mind from gross body. This supposition is if possible more absurd than that of Hobbes. Sensation and perception are of such a nature, that a mere *tendency towards* them is inconceivable. A thing must either be sensible and percipient, or insensible and inert: there is evidently no medium. Or if we could suppose each individual atom to have a *tendency towards* sensation, it would by no means follow that a number of such atoms brought together in any possible order would become one sentient, thinking, and active being. A number of bodies laid upon an inclined plain have each a *tendency* to roll downwards; but if the declivity of the plain be not such as that their separate tendencies may overcome the resistance opposed to each individual body by friction, the *united tendencies* of all the bodies when brought together will not be able to overpower the resistance of their united frictions. Just so is it with respect to sensation and perception: If the tendency of one atom cannot overcome one degree of inertness, the tendency of a thousand atoms will not overcome a thousand degrees of the same inertness.

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Only two
opinions at
present on
the subject.

We have just mentioned these absurd suppositions that our article might be complete: but it is proper to inform the reader, that, so far as we know, neither of them has for these many years been maintained by any philosopher of eminence either at home or abroad. The opinions on this subject, which at present divide the republic of letters, are two; and these alone are worthy of examination. One party maintains, That perception, memory, reason, and will, &c. are the powers of a being which must be immaterial and indivisible: The other alleges, That as we know nothing of these powers but from our own consciousness, and as we can trace them in ourselves to the brain and no farther, we have no reason to suppose that they are the powers of any substance distinct from matter. Both parties, however, distinguish that which in man is the

subject of thought from his external organs of sense, and agree to call it by the name of *mind*; though the one considers it as composed of the same first matter with the dust of the ground; whilst the other believes it to have no property whatever in common with that matter.

Were we to adopt some of the ancient methods of philosophising, this important question might be soon decided. A most respectable writer, who has laboured to restore the metaphysics of Plato and Aristotle, hopes to confute the materialists, by laying down what they must think arbitrary definitions of mind and matter, and then showing that the one is not the other. "In all the parts of the material world (says he) there is a perpetual *motion*: For the celestial bodies move constantly in one respect or another; and all here below is in a continual vicissitude of generation and corruption, which cannot be without *motion*. Now, where there is *motion*, there must be something that *moves*: What is *moved* I call *body*; what *moves* I call *mind*." From this definition he undertakes to prove, that mind must be immaterial. "That there is a relation between *moving* and *being moved* (says he), nobody can deny; and the relation is no other than that of *action* and *passion*. But the nature of relation is such, that it must necessarily be between two things at least; and it is further necessary, that the two things related should exist together. Hence, if there be that which *moves*, there must be a different thing that *is moved*; and wherever the one is, the other must necessarily be; so that nothing can move itself. This being established, I say that what *moves* must be either material or immaterial: for the one of these being the negation of the other, there can be no middle betwixt them; because a thing must necessarily *be*, or *not be*. If then it be immaterial, there is an end of the question: but if it be said to be material, then I say that it must be *moved* itself before it can move any thing else; for it is only in that way that body can move body. If then it must be first moved itself, but cannot itself move itself, what is it that moves it? If it be answered, That it is another material mover, then I repeat the same question, to which the same answer must be given: and so we have an infinite series of *material movers*, without any beginning or *principle of motion*. Now this is absurd, and contradictory to this first principle of natural philosophy, admitted by all philosophers ancient and modern, That *nothing can be produced without a cause*†."

For the immateriality of the human mind, and of every being endowed with the powers of perception and thought, the learned writer has better arguments; but it is upon this chiefly that he rests his persuasion, that mind is the only *mover* in the universe. It is needless to observe, that in the very definitions and axioms upon which this reasoning is built, the thing to be proved is taken for granted: for if it be self-evident,

(c) Scio fuisse philosophos quosdam, eisdemque viros doctos, qui corpora omnia sensu prædita esse sustinuerunt: Nec video, si natura sensationis in reactione sola collocaretur, QUOMODO refutari possint. Sed etsi ex reactione etiam corporum aliorum, phantasma aliquod nasceretur; illud tamen, remoto objecto, statim cessaret. Nam nisi ad retinendum motum impressum, etiam remoto objecto, apta habeant organa, ut habent animalia; ita tantum sentient, ut nunquam sensisse se recordentur. Sensationi ergo, quæ vulgo ita appellatur, necessario adhæret memoria aliqua. Hobbes's *Physic*, cap. 25. sect. 5.

Of Mind in general. dent, that what *moves* is, in the author's sense of the word, *mind*, that what is *moved* is *body*, and that *nothing can move itself*, all reasoning on the subject is superfluous. This, however, is so far from being self-evident, that a materialist may reply, "every animal moves itself, and yet every animal is nothing more than a system of matter." This position, whether true or false, can neither be proved nor confuted by arguments *à priori* founded on general definitions. That animals move themselves, and that to the senses they appear to be nothing else than systems of matter, are facts which cannot be controverted. If we would know whether they have in them a principle of motion which is not material, we must submit to the laws of induction (see *Logic*); and by investigating the essential qualities of matter, endeavour to ascertain whether a material system can be rendered active. That we ourselves have active powers, we know by the most complete of all evidence, *viz.* consciousness of their energies; and it has been already shown, that such powers as we experience in ourselves cannot exist but in a subject possessed of will and understanding. The question therefore to be first decided between the materialists and immaterialists is, Whether the powers of consciousness, understanding, and will, can result from the particular organisation of a system of matter? If they can, we have no reason to attribute them in man to any other source: If these powers appear necessarily to require an immaterial principle for their support, it will probably be granted, that an immaterial principle is the source of every power and every motion in the universe; and the doctrine of *mind*, in the strictest sense of the word, will be sufficiently established.

CHAP. II. Of the SUBSTANCE of the HUMAN MIND.

233 Argument for the immateriality of the human mind. THE most celebrated materialist of this or perhaps of any other age is Dr Priestley; who having in his own imagination divested matter of solidity, and reduced it to mere centres of attraction and repulsion, observes, that "if one *kind of substance* be capable of supporting all the known *properties* of man; that is, if those properties have nothing in them that is absolutely incompatible with one another; we shall be obliged to conclude (unless we openly violate the rules of philosophising, which will not authorise us to *multiply causes* or kinds of substance *without necessity*), that no other kind of substance enters into his composition; the supposition being manifestly *unnecessary*, in order to account for any appearance whatever.—All the properties that have hitherto been attributed to matter, may be comprised under those of attraction and repulsion. Besides these, man is possessed of the powers of *sensation* or *perception*, and *thought*. But if, without giving the reins to our imaginations, we suffer ourselves to be guided in our inquiries by the simple rules of

philosophising above mentioned, we must necessarily conclude, that these powers also may belong to the same substance that has also the properties of attraction, repulsion, and *extension* (D), which I as well as others call by the name of *matter*. The reason of the conclusion is simply this, that the powers of sensation or perception and thought, as belonging to man, have never been found but in conjunction with a certain *organised system of matter*; and therefore that those powers necessarily exist in and depend upon such a system. This at least must be our conclusion, till it can be shown that these powers are incompatible with the other known properties of the same substance; and for this I see no sort of pretence."

This is what Dr Priestley calls the proper and direct proof that the sentient principle in man is the material substance of the brain; and he enforces it by the following observations: "Had we formed a judgment concerning the necessary seat of thought by the circumstances that *universally accompany it*, which is our rule in all other cases, we could not but have concluded that in man it is a property of the *nervous system*, or rather of the brain; because, as far as we can judge, the faculty of thinking, and a certain state of the brain, always accompany and correspond to one another; which is the very reason why we believe that any property is inherent in any substance whatever. There is no instance of any man retaining the faculty of thinking when his brain was destroyed; and whenever that faculty is impeded or injured, there is sufficient reason to believe that the brain is disordered in proportion; and therefore we are necessarily led to consider the latter as the seat of the former. Moreover, as the faculty of thinking in general ripens and comes to maturity with the body, it is also observed to decay with it; and if, in some cases, the mental faculties continue vigorous when the body in general is enfeebled, it is evidently because in those particular cases the *brain* is not much affected by the general cause of weakness. But, on the other hand, if the brain alone be affected, as by a blow on the head, by actual pressure within the skull, by sleep, or by inflammation, the mental faculties are universally affected in proportion. Likewise, as the mind is affected in consequence of the affections of the body and brain, so the body is liable to be reciprocally affected by the affections of the mind, as is evident in the visible effects of all strong passions, hope or fear, love or anger, joy or sorrow, exultation or despair. These are certainly irrefragable arguments, that it is properly no other *than one and the same thing* that is subject to these affections, and that they are necessarily dependent upon one another. In fact, there is just the same reason to conclude, that the powers of sensation and thought are the necessary result of a particular organization, as that sound is the necessary result of a particular concussion of the air. For in both cases equally the one constantly accompanies the other; and there is not in nature a stronger

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(D) When Dr Priestley mentions the *extension* of corporeal substance, it must be remembered that he does not mean the extension of any real thing possessed of an independent existence. The extension belongs wholly to the *sphere* or the *combination* of spheres of *attraction* and *repulsion*. The centre itself, which attracts and repels, he repeatedly affirms not to have the dimensions even of a physical point; and he sometimes seems to entertain a doubt whether it be any thing more than a mere relative notion.

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stronger argument for a necessary connection or any cause and any effect. To adopt an opinion different from this, is to form an hypothesis without a single fact to support it." *

Though the ingenious author thinks, that if there be any foundation for the established rules of philosophy, this reasoning ought to be conclusive, he yet subjoins, for the greater satisfaction of his readers, some additional arguments, or rather, as he says, distinct illustrations of the great argument. They are as follows:

1. "That the faculty of thinking necessarily depends, for its *exercise* at least, upon a stock of ideas, about which it is always conversant, will hardly be questioned by any person. But there is not a single idea of which the mind is possessed but what may be proved to have come to it from the bodily senses, or to have been consequent upon the perceptions of sense. The notion, therefore, of the *possibility* of thinking in man, without an organized body, is not only destitute of all evidence from actual appearances, but is directly contrary to them; and yet these appearances ought alone to guide the judgment of philosophers.

2. "The only reason why it has been so earnestly contended for, that there is some principle in man that is not material, is, that it might subsist, and be capable of sensation and action, when the body is dead. But if the mind was naturally so independent of the body, as to be capable of subsisting by itself, and even of appearing to more advantage, after the death of the body; it might be expected to discover some signs of its independence before death, and especially when the organs of the body were obstructed, so as to leave the soul more at liberty to exert itself; as in a state of *sleep* or *fainting*, which must resemble the state of death; in which it is pretended that the soul is most of all alive, most active, and vigorous. But judging by appearances, the reverse of all this is the case.

3. "If the mental principle was, in its own nature, immaterial and immortal, all its particular faculties would be so too; whereas we see that every faculty of the mind without exception is liable to be impaired, and even to become wholly extinct, before death. Since, therefore, all the faculties of the mind, separately taken, appear to be mortal, the substance or principle in which they exist must be pronounced to be mortal too.

4. "If the sentient principle in man be immaterial, it can have no *extension*; it can neither have length, breadth, nor thickness; and consequently every thing within it, or properly belonging to it, must be *simple* and *indivisible*. Let us now consider how this notion agrees with the phenomena of sensation and ideas. It will not be denied, but that sensations or ideas properly exist *in the soul*, because it could not otherwise retain them, so as to continue to perceive and think after its separation from the body. Now, whatever ideas are in themselves, they are evidently produced by external objects, and must therefore correspond to them; and since many of the objects or archetypes of ideas are divisible, it necessarily follows, that the ideas themselves are divisible also. But, how is it possible that a thing (be the nature of it what it may) that is *divisible*, should be contained in a substance, be the nature of it likewise what it may, that is *indivisible*?

If the archetypes of ideas have extension, the ideas which are expressive of them, and are actually produced by them according to certain mechanical laws, must have extension likewise; and therefore the mind in which they exist, whether it be material or immaterial, must have extension also. But how any thing can have extension and yet be immaterial, without coinciding with our idea of mere empty *space*, I know not."

To the argument, which is here chiefly insisted on as being agreeable to the established rules of philosophy, a very able reply has been made, which we shall give in the words of its elegant and spirited author. But before we attempt to dig up the foundation of the Doctor's system, it may not be improper to demolish, if possible, the additional buttresses by which it is strengthened. An experienced general, before he storm a citadel which he knows to be strongly fortified and skilfully defended, will take care to raze every less important redoubt from which the enemy might annoy him in his rear.

Because the faculty of thinking in general ripens, comes to maturity, and decays with the body, and the body on the other hand is affected by the affections of the mind, the Doctor affirms that we have the same reason to conclude, that the powers of sensation and thought are the necessary result of a particular organisation, as that sound is the necessary result of a particular concussion of the air. This argument is conclusive only upon the supposition that there is no *positive* evidence whatever for the immateriality of the being which is the subject of thought. If the other reasonings for the materiality and immateriality of the mind be of equal weight, this argument ought doubtless to turn the balance; but if there be the smallest preponderancy in behalf of the immaterialists, it is a mere begging of the question to attempt to counteract it by any inference which can be drawn from the mutual affections of the body and mind. If two such heterogeneous beings as an immaterial mind and an organised body can be supposed united in one person, they must necessarily affect each other; and to affirm, on account of this reciprocal affection, that they are *one and the same*, is equally absurd as to say that an electrician and his apparatus are *one and the same*. Dr Priestley himself did not at first perform his electrical experiments with so much ease as after he had acquired facility by long practice, nor could he even yet perform them so neatly with a bad as with a good apparatus.

That which the Doctor calls the first illustration of his argument might be admitted, and the force of the argument itself be consistently denied. Some kind of organised body may be necessary to the mind as an instrument without which it could not exert its faculties; but it would certainly be rash to infer that the mind must *therefore* be a system of matter. An anvil and a hammer are necessary to the exercise of the blacksmith's art; but what would be thought of him who should from this fact conclude, that the blacksmith himself must be a system of iron? This, therefore, instead of illustrating the great argument, seems to be wholly foreign from the question in debate; and it has in fact been admitted by Dr Price and thousands of others who reject the doctrine of materialism, as an impious absurdity. The second illustration

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* Corre-
spondence
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illustration, however, is more to the purpose; and as it is not new, we shall give it an old answer.

Why do not we perceive external objects in our sleep or in a swoon? "Because (says Mr Wollaston), † the passages are become impracticable, the windows shut, and the nerves being obstructed, or somehow rendered for the time useless, can transmit no information to it. Why, however, does it not reason and think about something or other? Because, all the marks by which things are remembered, being for the present choked up or disordered, the remembrance of those objects about which it is wont to employ itself, and even of the words (or other signs) in which it uses to reason, and to preserve the deductions and conclusions it makes, is all suspended at least for the time; and so its tables being covered, its books closed, and its tools locked up, the requisites for reasoning are wanting, and no subject offers itself to exercise its thoughts, it having yet had little or no opportunity to take in higher objects and more refined matter for contemplation. And, to conclude, if it be demanded, Why any one should imagine that the soul may think, perceive, act, after death, when it doth not do this in sleep, &c.? the answer is, Because those inclosures and impediments which occasioned the forementioned intermissions, and those great limitations under which it labours at all times, will be removed with its enlargement out of the body. When it shall in its proper vehicle be let go, and take its flight into the open fields of heaven, it will then be bare to the immediate impressions of objects: And why should not those impressions which affected the nerves, that moved and affected the vehicle and soul in it, affect the vehicle immediately when they are immediately made upon it, without the interposition of the nerves? The hand which feels an object at the end of a staff, may certainly be allowed to feel the same much better by immediate contact without the staff."

The opinion, that the soul is united to some fine vehicle, which dwells with it in the brain, and goes off with it at death, was not peculiar to Mr Wollaston. It was thought extremely probable by Dr Hartley, and shall be shown afterwards to have been a very ancient opinion; but we do not quote it at present as either well or ill founded, but only as sufficient in conjunction with the reasoning of its author, to obviate the force of Dr Priestley's second illustration of his argument for the materiality of mind, provided the argument itself be not more powerful than any which the immaterialists can bring against it.

The Doctor's third illustration we have already obviated, when we accounted for the mind and the body mutually affecting each other; and we might refer to Dr Price's answer (E) to the fourth, as being, in our opinion, a full confutation of it. But as that au-

thor's notions of mind and ideas differ in some respects from our own, we shall examine this objection to the doctrine of the immaterialists upon principles which we believe Dr Priestley more inclined to admit.

That the sentient principle in man, if it be immaterial, can have no extension, is a truth which we think cannot be controverted; and if so, every thing in that principle must be simple and indivisible. Thus far we agree with Dr Priestley; but with respect to what follows we differ from him entirely. The agitation in the brain, which is the immediate cause of sensation, must indeed correspond to the impression *ab extra* by which it is produced, and therefore must have the property of extension; but that agitation, whatever it be, is not itself sensation any more than a bludgeon is a blow or a sword is a wound. Dr Priestley, indeed, in answer to Dr Price, affirms, that, according to Hartley's theory, ideas are only vibrations in the brain; but whoever shall take the trouble to examine that theory himself, will not find that its author ever advances such an opinion, or considers vibrations as any thing more than the instruments by which sensations and ideas are excited in the sentient principle. A real and proper idea, as we have often repeated, is nothing else than a fainter sensation; but no sensation, from whatever cause it may proceed, is itself extended; nor could we, without memory, the reasoning faculty, and the power of local motion, have acquired from mere sense any notion of extension at all: (See sect. 3. chap. i. Part I.) Sensations and ideas are those appearances (if we may so say), which vibrations or some other motion in the brain excite in the mind; but a half appearance is an absurdity. A man may view half a tree with his eyes, and he may contemplate the idea of half a tree in his mind; but he cannot have half a view or half an idea of any thing. Sensations and ideas result from the mutual agency of the brain and sentient principle upon each other; and if the agency of the brain be vibration, more of it may vibrate at one time than at another: but surely the mere relation between its agency at any time and the agency of the mind, can neither have extension nor be divisible; for who ever thought of extending or dividing relations? On this subject it is extremely difficult to write with perspicuity and precision; and what we have said may very possibly be misunderstood. Our notion is to ourselves clear and determinate; but language which was not invented by metaphysicians, wants words in which it may be properly expressed. Perhaps the reader may understand what we mean, when we say that a sensation or an idea is the instantaneous effect of the mutual agency of the brain and sentient principle. Of this we think every man, by a little attention, may be perfectly convinced, though it may be impossible ever to discover the precise na-

(E) In *Disquisitions*, p. 37 and 102, it is asserted, that ideas are certainly divisible. "This seems to me very absurd. It would be as proper to assert ideas to be hard or round. The idea of an object is the apprehension, view, or notion of it; and how can this be divisible? Perception is a single and indivisible act. The object perceived may be divisible; but the perception of it by the mind cannot be so. It is said in page 95, that if ideas are not things distinct from the mind, a mind with ideas and a mind without ideas would be the same.—I maintain, that ideas are not distinct from the mind, but its conceptions; or not things themselves, but notions of things. How does it follow from hence, that a mind with or without ideas is the same? It would seem that this follows much more from the contrary assertion." *Correspondence between Dr Price and Dr Priestley.*

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ture of this agency; and if so, it is plain that sensations and ideas cannot be divided, for no instantaneous effect of any kind is divisible. A sensation, and of course a simple and original idea, neither has extension itself, nor suggests the notion of extension *ab extra*. By running the hand or any other member along a solid body, we feel continued resistance: this feeling, or the idea of this feeling, becomes in time so closely associated with all our sensations of touch and sight, that the one cannot be separated from the other; and these associations are what Dr Priestley calls *extended ideas*. Upon the whole then, we think it apparent, that our sensations, and the reliëts of our sensations, are unextended and indivisible, (F); and that though they suggest to us the existence of extended things *ab extra*, the sentient being *may* be unextended and indivisible.

Having thus examined Dr Priestley's auxiliary arguments for the materiality of mind, we now proceed to consider his main and direct proof. To this, as we have observed, so able a reply has been made, that it would be injustice to our readers not to lay it before

them, in the words of its author. "I readily acknowledge (says this spirited essayist*), that the power of sensation or perception never having been found but in conjunction with a certain organized system of matter, we ought, as philosophers, to conclude that this power necessarily exists in, and results from, that organized system, unless it can be shown to be incompatible with other known properties of the same substance. On the other hand, it must be admitted, that constant conjunction implies *necessary* connection only when reasons cannot be discovered to prove the conjunction to be accidental and arbitrary. In the present instance, it is alleged, that discernibility is a property of matter absolutely incompatible with the property of sensation or perception; or in other words, that sensation is a power or property incapable of division. But as the power of the entire system is clearly nothing more than the sum or aggregate of the powers of all the parts, it necessarily follows, that the primary particles of which the system is composed must, upon the material hypothesis, possess distinct powers of sensation; and that those

(F) We affirm this only of *human* sensations and ideas, because these are the only sensations and ideas of which we are conscious, and about which we can reason. Other animals are sentient as well as man, and appear to have their sensations excited by impressions *ab extra*; but whether in every species of animals a single impression excites but one sensation common to the whole animal, or different sensations which are felt each by a different faculty or sentient principle, is a question which we are not able to answer. We make this remark, because from the phenomena of sensation in the earth-worm and other reptiles, some philosophers of eminence having supposed, that in these creatures the sentient faculty belongs to the material system, and is divisible with it; have thence concluded, we think rashly, that all arguments for the immateriality of the human mind are founded merely on our ignorance. We call this conclusion rash; because, though we know perfectly what a human sensation is, we have so little knowledge of the nature of sensation in worms, that what may be true of the one *principle* of sensation may be false of the other. Indeed, if we are to judge from the phenomena, this is actually the case. It appears from experiments made by Abbé Spallanzani and others, that if a certain number of rings be cut off either from the anterior or posterior part of a worm, or even from both, the remainder will not only continue to live and be sentient, but will also regenerate a new head and a new tail, and become again a complete worm. Nothing like this takes place in man or in the higher orders of animals; and therefore, were it certain that the sentient principle in the worm is diffused through the whole system and divisible with it, we could not infer that the principle of such sensations as we are conscious of, is likewise extended and divisible. It is, however, so far from being certain that the sentient principle is diffused through the whole worm, that nothing necessarily follows from this fact, but that its seat is at some distance from either extremity. Nay, were it true, as perhaps it is, that a worm may be so divided, as that each of the two sections shall retain life, sensation, and this reproductive power, we would not therefore be authorized to conclude that the sentient principle is *one*, co-extended and divisible with the material system. The earth worm, like many other reptiles, being an hermaphrodite, which unites in itself both sexes, may possibly consist of two animated systems; which though united by some bond of connection, by which sensation is communicated from the one to the other, are yet in themselves perfectly distinct. Should this, upon proper investigation, be found to be the case; and should it likewise be found; that when a worm is divided into three or more parts, only one or two of these parts continue to live, there would be no room whatever for supposing that even in these creatures the principle of sensation is extended and divisible. In the mere power of reproducing amputated parts, when that power is considered by itself, there is nothing more wonderful than in the growing of the nails of our fingers or the hairs of our heads. The only thing which seems to militate against the simplicity of the principle of sensation in worms, is the continuance of life, &c. with both parts of a worm when cut into two by a knife or pair of scissors; but if a worm be found to have two seats of sensation analogous to the brain in higher animals, and if it be likewise found that life continues only in such sections as retain at least one seat of sensation, the sentient principle in the worm may be as simple and indivisible as in any animal whatever. We neither wish nor expect much stress to be laid upon these hints and conjectures. Should they induce any of our physiological readers, who have leisure, and are at the same time skilled in philosophy, properly so called, to institute a set of experiments upon worms, and such reptiles, and to trace apparent effects to their higher causes, they might eventually lead to important discoveries. In the mean time, it is sufficient for our purpose to observe, that whatever be the sentient principle or principles in the earth-worm, it is obvious that the whole animal cannot in any case be conscious, as man undoubtedly is, of *one individual sensation*; and that therefore no arguments built upon the phenomena accompanying sensation in worms, can be of any importance in the controversy about the materiality or immateriality of the human mind.

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those powers combined constitute the indivisible power of sensation belonging to the system; or, in other words, that the *indivisible* power of sensation is a *divisible* power, nay, an infinitely divisible power, if matter be, as philosophers in general allow, an infinitely divisible substance—a conclusion obviously and grossly ridiculous. We are then compelled to acknowledge, that sensation or perception is not the property of a material substance; *i. e.* if the common mode of expression be retained, it is the property of an immaterial substance; or, to avoid verbal contention, it is a property not resulting from, or necessarily connected with, the organical system, but a property wholly foreign, superinduced, and adventitious. (G)

“In opposition to this reasoning, the materialists affirm, that entire systems may possess, and they think themselves warranted to pronounce that organized systems of matter actually do possess, powers essentially different from those which inhere in the several parts. Amongst various familiar though striking illustrations of this truth, it has been said, that a rose possesses the property of sweetness or fragrance, a globe the property of sphericity, a harpichord the property or power of producing harmony, *aqua regia* the property of dissolving gold, &c. though the component particles of these different organized systems are themselves totally destitute of the powers and properties here enumerated.

“The immaterialists, in reply, assert, that it is not only false in fact, but a direct contradiction, and an absolute impossibility in the nature of things, that a system should possess any property which does not inhere in its component parts. To assert that the power of the whole is the sum or aggregate of the powers of all the parts, is an identical and self-evident

proposition, the whole and all the parts being terms precisely synonymous. Whoever, therefore, calls in question the truth of this axiom, must maintain that the power of the whole is something different from the power of all the parts, *i. e.* that the power of the whole is *not* the power of the whole.

“It will be easy to demonstrate the correspondence of facts with this plain and simple theory. For this purpose, it is necessary to observe, that the properties of matter, or what are generally denominated such, may be divided into real and nominal, which Locke and others have called primary and secondary qualities. Figure, magnitude, and motion, are qualities really inherent in matter; but figure, magnitude, and motion, eternally varied, can produce only different combinations of figure, magnitude, and motion. There are also powers, or qualities, vulgarly considered as inherent properties of matter organically disposed, which are really and truly qualities or affections of the mental or percipient principle, and have no existence when not perceived. Thus the sweetness or fragrance of the rose, considered as mere sweetness and fragrance, can be nothing but an affection of the mind; considered as a quality of the rose, they can mean nothing more than a certain arrangement, configuration, and motion of parts, which in some inexplicable manner produces the sensation of sweetness. In this instance, therefore, the power of the whole is plainly the aggregate of the powers residing in the parts, by the motion and organization of which a certain effect is produced upon a foreign and percipient substance.

“But a globe, we are told, possesses the property of sphericity, though not a single particle amongst that infinite number of which the globe is constituted is itself of a spherical form. The fallacy of

(G) This argument is not new. It was long ago urged by Dr Clarke against Mr Dodwell; and some of our readers may not be ill pleased to see it stated by so masterly a reasoner: “That the soul cannot possibly be *material*, is demonstrable from the single consideration of bare sense or consciousness. For matter being a divisible substance, consisting always of separable, nay of actually separate and distinct parts, it is plain that unless it were essentially conscious, in which case every particle of matter must consist of innumerable separate and distinct consciousnesses, no system of it, in any possible composition or division, can be an individual conscious being. For suppose three or three hundred particles of matter, at a mile or any given distance one from another, is it possible that all these separate parts should in that state be one individual conscious being? Suppose then all these particles brought together into one system, so as to touch one another, will they thereby, or by any motion or composition whatsoever, become one whit less truly distinct beings than they were when at the greatest distance? How then can their being disposed in any possible system make them one individual conscious being? If you will suppose God by his infinite power superadding consciousness to the united particles, yet still these particles being really and necessarily as distinct beings as ever, cannot be *themselves* the *subject* in which that individual consciousness inheres; but the consciousness can only be superadded by the addition of something, which in all the particles must still itself be but one individual being. The soul, therefore, whose power of thinking is undeniably one individual consciousness, cannot possibly be a material substance.” *Clarke's Letter to Mr Dodwell, 2d edition.*

That the same mode of reasoning was known to the ancients, Cudworth has shown by numerous quotations; and as an argument certainly loses nothing by antiquity, or by having occurred to thinking men in distant ages, we shall lay before our readers two passages from Plotinus, of which the extract from Clarke's letter (though we are persuaded it was not borrowed by the author) must be considered as little more than a paraphractical translation.

—τι τοιουν φησουσιν, οι την ψυχην σωμα ειναι λεγοντες, πρωτον μιν περι εκαστου μέρους της ψυχης της εν τω αυτω σωματι, ποτερον εκαστον ψυχην, ο.α. εστι και η ολη; και παλιν του μέρους το μέρος; ουδεν αρα το κληγεθος συνεκαλλεστο τη ουσια αυτης· καιτοι ιδειγε ποσου τινος οντος· αλλα και ολον πολλαχη, οπερ σωμασι παρειναι αδυνατον, εν πλειοσι το αυτο ολον ειναι, και το μέρος ε περ το ολον, υταρχειν· ει δε εκαστον των μερών, ου ψυχην φησουσιν, εξ αφυχων ψυχην αυτοις υπαρξει. *En. IV. Lib. 7. timo. Cap. 5.*

The same argument is elsewhere stated thus: ει δε εκαστον ζων ηχοι, και εν αρχει· ει δε μηδενος αυτων ζων ηχοιλος η συνοδος πιποινη ζων, αλοπον· μαλλον δε αδυνατον συμφορησιν σωματων ζων εργαζεσθαι, κα νουν γενναν τα ανοηλα. *En. IV, Lib. 7. Cap. 2.*

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of this illustration is, however, as easily demonstrable as that of the former. The sphericity of a globe is evidently the sum or aggregate of the curvilinear or convex parts which compose its surface; and the property of the whole is neither more nor less than the combined properties of all its parts. No one doubts, that by new compositions or arrangement of material particles possessing magnitude, figure, and motion, an endless diversity of phenomena may be produced, to which it may be necessary to apply new names. New names, however, do not constitute new properties; and though we give to a globe the appellation of an entire system, and ascribe to it the property of sphericity, we know at the same time that it is really nothing more than a collection of thousands of millions of particles, actually separate and distinct, arranged in that particular form which we denominate spherical. But this can never be regarded as in the remotest manner analogous to the *creation* of the power of perception, in consequence of a certain organical arrangement or disposition of impercipient particles. Though sphericity is, indeed, the property of the entire sphere, yet every part of the sphere, if divided, possesses its share of sphericity. But if the percipient principle be divided, what would become of the power of perception? A sphere equally divided becomes two hemispheres; does a perception, when divided in like manner, become two demi-perceptions?

"The same reasonings may easily be transferred, and applied to the harpsichord. Can any one be absurd enough to affirm that the power of harmony resides in the harpsichord, as the power of perception does in the mind? After the utmost skill of the artificer has been exerted, we discover nothing more in the harpsichord than new modifications of the old properties of figure, magnitude, and motion, by means of which certain vibrations are communicated to the air, which, conveyed by the medium of the auditory nerves to the sensorium, produce the sensation of harmonic sounds. These new modifications are therefore attended, indeed, with new and very wonderful effects; but then those effects are produced upon, and are themselves modifications of, the sentient or percipient faculty. And though it is wholly incomprehensible to us in what manner these effects, that is, these *sensations*, are produced, we well know, and perfectly comprehend, that they are not new powers belonging to any organized system of matter; that they have no existence but in a mind perceiving them; and that they are far from militating against that grand and universal axiom, that the power of the whole is nothing more than the united powers of all the parts.

"As to the last instance adduced, of the power of *aqua regia* to dissolve gold, though neither the spirit of salt, nor the spirit of nitre of which it is compounded, separately possesses that power, it is plain, that from the union of these two substances, certain new modes of configuration and motion result; and the solution of gold is the consequence of this new arrangement and motion of the parts. But the particles of which the menstruum is composed were always possessed of the properties of figure and motion; and what is styled a new property, is clearly nothing more than a new effect of the old properties differently modified. In a word, the advocates for materialism may safely

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be challenged to produce, in the whole compass of nature, a case which bears the least analogy to that which these instances are most unphilosophically adduced to prove and to illustrate. It is an absurdity which transubstantiation itself does not exceed, to maintain that a whole is in reality any thing different from its component parts; and all nature rises up in confutation of an assertion so monstrous and extravagant. To affirm that perception can arise from any combination of impercipient particles, is as truly ridiculous, as to affirm that a combination of the seven primary colours with the four cardinal virtues may constitute a planet. It is equivalent to an assertion, that an epic poem might be composed of parallelograms, cones, and triangles. In a word, it is an absurdity not less real, and little less obvious, than that of the blind man who thought that the idea of a scarlet colour resembled the sound of a trumpet."

If matter be taken in the common acceptation, to be a solid, extended, and inert substance, this reasoning for the immateriality of the sentient principle in man appears to us to have the force of demonstration, which no difficulties or partial objections, arising from our inability to conceive the bond of union between two such heterogeneous substances as mind and body, can ever weaken, and far less overturn. But the modern materialists deny that matter is either solid or inert. "All those facts (say they) which led philosophers to suppose that matter is impenetrable to other matter, later and more accurate observations have shown to be owing to *something else* than solidity and impenetrability, viz. a *power of repulsion*, which for that reason they would substitute in its place. The property of *attraction* or repulsion (says Dr Priestley) appears to me not to be properly what is *imparted* to matter, but what really *makes it to be what it is*; inasmuch, that without it, it would be nothing at all; and as other philosophers have said,—'Take away solidity, and matter vanishes,' so I say, 'Take away attraction and repulsion, and matter vanishes.'" If this be admitted, the ingenious author hopes that we shall not consider matter with that contempt and disgust with which it has generally been treated, there being nothing in its real nature that can justify such sentiments respecting it.

We know not why, upon any hypothesis, matter should be viewed with contempt and disgust,—²³⁶ Whether penetrable or impenetrable, every consistent theist considers it as one of the creatures of God perfectly fitted to answer all the purposes for which it was intended: but were it really destitute of solidity, and endowed with the powers of attraction and repulsion, we should still be obliged to consider it as incapable of the powers of sensation and thought. If we have any notion at all of what is meant by centres of attraction and repulsion (of which indeed we are far from being confident), it appears to us to be intuitively certain, that nothing can be the result of any possible combination of such centres, but new and more enlarged spheres of attraction and repulsion. But surely consciousness, sensation, and will, are as different from attraction and repulsion, as a cube is from the sound of a trumpet, or as the sensations of a felon in the agonies of death are from the attraction of the rope by which he is hanged. If this be admitted, ²³⁷ and

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and we are persuaded it will be denied by no man whose understanding is not clouded by an undue attachment to paradoxes, the sentient principle cannot possibly be matter: for if, when the powers of attraction and repulsion are taken away, matter vanishes; and if consciousness and sensation are not attraction and repulsion; it is not more evident that three and two are not nine, than that the substance which attracts and repels cannot be that which is conscious and percipient.

Locke, who was certainly no materialist, as he repeatedly affirmed, and indeed demonstrated, that thought could never be the result of any combinations of figure, magnitude, and motion, was yet of opinion, that God by his almighty power might endow some systems of matter with the faculties of thinking and willing. It is always with reluctance that we controvert the opinions of so great a man; and it is with some degree of horror that we venture in any case to call in question the power of Omnipotence.—But Omnipotence itself cannot work contradictions; and it appears to us nothing short of a contradiction, to suppose the individual power of perception inhering in a system which is itself extended and made up of a number of separate and distinct substances. For let us suppose such a system to be six feet long, three feet broad, and two feet deep (and we may as well suppose a system of these dimensions to be percipient, as one that is smaller), then it is plain, that every idea must be extended, and that part of it must be in one place, and part in another. If so, the idea of a square inch will be six feet long, three feet broad, and two feet deep; and what is still harder to be digested, the several parts of this idea will be at a great distance from each other, without any bond of union among them. The being which apprehends one extremity of the idea, is, by the supposition, six feet distant from the being which apprehends the other extremity; and though these two distinct beings belong to one system, they are not only separable, but actually separated from each other as all the particles of matter are. What is it then that apprehends as *one* the whole of this extended idea? Part of it may be apprehended by one particle of matter, and part of it by another; but there is nothing which apprehends, or can apprehend, the whole. Perhaps it will be said, the power of apprehension is not divided into parts, but is the power of the one system, and therefore apprehends at once the whole idea. But a power or faculty cannot be separated from its subject, power which inheres in nothing being confessedly impossible; and a material system is not *one subject* in which any individual power or faculty can inhere. There must,

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therefore, be united to the system some *one* being, which is the subject of thought, and which is unextended as well as indivisible. This, we say, follows undeniably. For, let us suppose, that an extended being without separable parts is possible, and that such a being is percipient; it is obvious, that the whole of any one of its perceptions could not be in one place. Now, though we should grant to Dr Priestley and other materialists, that every idea of an extended substance has itself three dimensions, and is incorporated and commensurate with the whole percipient system; what, upon this supposition, shall we think of consciousness and of the perception of truth? Is consciousness or truth extended? If so, one side or superficies of consciousness, or of a truth, may be greater or less than another, above or below, to the right or to the left; and it will be very proper and philosophical to speak of the length, breadth, and depth, of consciousness or of truth. But surely to talk of the place, or the extension of these things, is as absurd as to talk of the colour of sound, or the sound of a triangle; and we might as well say, that consciousness is green or red, as that it is an ell or an inch long; and that truth is blue, as that it has three dimensions.

This reasoning is somewhat differently stated by Cudworth; who observes, that if the soul be an extended substance, "it must of necessity be either a physical point (*i. e.* the least extension possible, if there be any such least extension), or else it must consist of more such physical points joined together. As for the former of these, it is impossible that *one single atom*, or *smallest point* of extension, should be able to perceive distinctly all the *variety* of things, *i. e.* take notice of all the *distinct* and *different* parts of an *extended object*, and have a *description* or *delineation* of the whole of them upon itself (for that would be to make it the least, and not the least, possible extension at the same time:). Besides, to suppose every soul to be but one *physical point*, or the *smallest possible extension*, is to suppose such an essential difference in matter or extension, as that some of the *points* thereof should be *naturally* devoid of all *life*, *sense*, and *understanding*; and others, again, *naturally sensitive* and *rational*. And even should this absurdity be admitted, it would yet be utterly inconceivable how there should be *one*, and *but one*, *sensitive* and *rational* atom in every man; how this atom of so *small* dimensions should actuate the whole system; and how it should constantly remain the same from infancy to old age, whilst all the other parts of the system transpire perpetually, and are succeeded by new matter (H).

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(H) Should it be said, that this essential difference between the atoms of matter is not fortuitous; that some of them are created intelligent for the express purpose of animating systems of others which are unintelligent; and that these intelligent atoms do not operate upon the systems with which they are united, by the *vis inertiae*, *solidity*, or *extension*, of matter, but by the energies of understanding and will: Should this (we say) be alleged, surely it may be asked, for what purpose they are conceived to have the quality of extension? It is evidently of no use; and it has been already shown, and shall be more fully shown afterwards, that by our notions of consciousness and understanding, we are so far from being led to suppose the subject of these powers extended, that we cannot suppose any relation whatever between them and extension. But if these intelligent atoms be divested of their quality of extension, they will be transformed from matter to mind, and become the very things for the existence of which we plead.

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be extended substances consisting of many points one without another, and all concurring in every sensation; then must every one of these points perceive either a *point* only of the object, or else the *whole*. Now, if every *point* of the *extended soul* perceives only a *point* of the *object*, then is there no *one thing* in us that perceives the whole, or that can compare one part of the object with another. On the other hand, if every *point* of the *extended soul* perceive the *whole object* at once, then would there be *innumerable perceptions* of the same object in every sensation; as many, indeed, as there are points in the extended soul.— And from both these suppositions it would alike follow, that no man is *one single percipient* or person, but that in every man there are innumerable distinct *percipients* or *persons*; a conclusion directly contrary to the infallible evidence of consciousness (1)."

Cogent as these arguments for the immateriality of the sentient principle appear to be, they have been lately treated with the most sovereign contempt by a writer who professes to be a disciple of Dr Priestley's, but who seems not to have learned the modesty or the candor of his master. Dr Priestley labours to prove, that to account for the phenomena of perception and volition, &c. it is not necessary to suppose an immaterial principle in man. Mr Cooper with greater boldness affirms, and undertakes to demonstrate with all the parade of mathematical precision ‡, that such a principle is impossible. Though the authority of this philosopher in such inquiries as

‡ *Traacts*
Ethical,
Theological,
and Political,
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depend not immediately upon the retort and the furniture, is certainly not great, he yet utters his dogmas with such confidence, that it may not be improper to examine the chief arguments upon which they rest.

"Suppose (says he) the soul to have no common property with matter; then, nothing can act upon any other but by means of some common property. Of this we have not only all the proof that induction of known and acknowledged cases can furnish, but that additional proof also which arises from the impossibility of conceiving how the opposite proposition can be true. But by the supposition, the soul has no property in common with matter; and therefore the soul cannot act upon matter. But by the supposition of every system of immaterialism (except those of Malbranche, Berkeley, and Leibnitz), it is deemed an essential property of the soul, that it acts upon the body, or upon matter; therefore the soul can and cannot act upon matter at the same time, and in the same respect. But this is a contradiction in terms; and as two contradictions cannot both be true at the same time, the supposition of the existence of an immaterial soul cannot be true; that is, the soul does not exist."

This reasoning, the reader will observe, is carried on with all the pomp of mode and figure. The propositions hang upon each other like the several steps of an algebraic process: but as in such processes one error unwarily admitted produces a false result, so in demon-

(1) As the materialists endeavour to prejudice the public against the notion of an unextended soul, by representing it as a fiction of *Des Cartes*, altogether unknown to the ancients, it may not be improper to give our readers an opportunity of judging for themselves how far this representation is just.—*Plotinus*, reasoning about the nature of the soul from its energies of sensation, expresses himself in these words:—*ἵτι μελλει αισθανεσθαι τινος, ἐν αὐτῷ δεῖ εἶναι, καὶ τῷ αὐτῷ παντὸς ἀντιλαμβανεσθαι καὶ εἰ δια πολλῶν αισθητηρίων πλὴν ταῖς εἰσιονίαις, ἢ πολλὰ περὶ ἐν ποιοῦντες καὶ δι' ἑνὸς ποικίλων, εἶον προσωποῦντος γὰρ ἄλλο μὲν ρινὸς ἄλλο δὲ ὀφθαλμῶν, ἄλλα ταῦτον ὁμοῦ πάντων καὶ εἰ το μὲν δι' ὀμμάτων τὸ δεῖ δι' ἀκοῆς, ἐν τῇ δεῖ εἶναι εἰς ὁ αὐτῷ ἢ πῶς ἀν εἰποι ὅτι ἑτέρα ταῦτα, μὴ εἰς τὸ αὐτῷ ὁμοῦ τῶν αισθησέων εἶδον τῶν.* "That which perceives in us, must of necessity be one thing, and by one and the same indivisible perceive all; and that whether they be more things entering through several organs of sense, as the many qualities of one substance, or one various and multiform thing, entering through the same organ, as the countenance and picture of a man. For it is not one thing in us that perceives the nose, and another thing the eyes; but it is one and the self-same thing that perceiveth all. And when one thing enters through the eyes, another through the ears, both these also must of necessity come at last to one indivisible; otherwise they could not be compared together, nor one of them be affirmed to be different from the other, the several ideas of them meeting no where in one place." Pursuing the same argument, and having observed, that if what perceiveth in us be extended, then one of these three things must of necessity be affirmed, that either every part of this extended soul perceives a part only of the object, or every part of it the whole object; or else, that all comes to some one point, which alone perceives both the several parts of the object and the whole: he observes of the first of these suppositions,—*μεγεθει οὐκ ἐστὶ τούτῳ, ζυμμερίζοιτο ἀν' ὥστε ἄλλο αὐτοῦ μέρος, καὶ μηδὲν ἡμῶν ὅλου τοῦ αισθητοῦ αἰσθητὴν εἶχεν ὥστε ἀν εἰ ἐγὼ μὲν αὐτοῦ συ δεῖ αὐτοῦ αισθεῖο.* "If the soul be a magnitude, then must it be divided, together with the sensible object, so that one part of the soul must perceive one part of the object, and another another; and nothing in it, the whole sensible; just as I should have the sense of one thing, and you of another." Of the second supposition, he writes in this manner: *εἰ δὲ ὅτιον παντὸς αισθησέται· εἰς ἀπειρά διαίρεσθαι τοῦ μεγέθους πεφυκότος, ἀπειροὺς καὶ αισθησεις καθ' ἑκάστον αισθητὸν συμπεσέται γιγνεσθαι ἑκάστῳ ὅιον τοῦ αὐτοῦ ἀπειροὺς ἐν τῷ ἰγμονονεῖ ἡμῶν εἰκόνας.* "But if every part of the extended soul perceive the whole sensible object, since magnitude is infinitely divisible, there must be in every man infinite sensations and images of one object."—And as for the third and last part of this disjunction, *Plotinus* by asserting the infinite divisibility of body, here shows that the supposition of any one physical point is in itself an absurdity. But if it were not, he agrees with *Aristotle* in asking *πῶς τῷ ἀμερεῖ τὸ μερίδιον*—thereby plainly indicating, that the sentient principle is totally separated from extension, and can neither be considered as extended like a superficies or solid, nor unextended as a physical point.

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demonstrative reasonings one unfound argument admitted into the premises is necessarily productive of error in the conclusion. When the author affirms, "that nothing can act upon any other but by means of some common property," he affirms without the shadow of proof what is certainly not self-evident. He says, indeed, that of this we have all the proof that induction of known and acknowledged cases can furnish; but unless consciousness be calculated to deceive us, this is unquestionably a mistake. Matter, he repeatedly affirms, has no other properties than those of attraction and repulsion: but a man moves his arm by a mere energy of will; and therefore, according to this demonstrator, an energy of will must be either material attraction or material repulsion. If so, it is reasonable to conclude, that when a man draws his hand towards his head, the centre of his brain exerts its power of *attraction*; and that when he extends his arm at full length before him, the same centre exerts its power of *repulsion*. We beg pardon of our readers for detaining them one moment upon such absurdities as these: yet we cannot dismiss the argument without taking the liberty to ask our all-knowing author, How it comes to pass that the same centre sometimes attracts and sometimes repels the same substance at the same distance; nay, that it both attracts and repels substances of the same kind, at equal distances, and at the very same instant of time? This must be the case, when a man puts one hand to his head, and thrusts another from him; and therefore, if these operations be the effect of attraction and repulsion, it must be of attraction and repulsion, to which induction of known and acknowledged cases furnishes nothing similar or analogous, *i. e.* of such attraction and repulsion as, according to Mr Cooper's mode of reasoning, does not exist. The truth is, that we are not more certain that we ourselves exist, than that an energy of will is neither attraction nor repulsion; and therefore, unless all matter be endued with will, it is undeniable, that, whatever be the substance of the soul, one thing acts upon another by a property not common to them both. In what manner it thus acts, we pretend not to know: but our ignorance of the manner of any operation is no argument against the reality of the operation itself, when we have for it the evidence of consciousness and daily experience; and when the author shall have explained to general satisfaction how material centres attract and repel each other at a distance, we shall undertake to explain how one thing acts upon another with which it has no common properties.

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Suspicious, as it should seem, that this reasoning has not the complete force of mathematical demonstration, the author supports his opinion by other arguments. "Whatever we know (says he), we know by means of its properties, nor do we in any case whatever certainly know any thing but these; and we infer in all cases the existence of any thing which we suppose to exist from the existence of its properties. In short, our idea of any thing is made up of a combination of our ideas of its properties. Gold is heavy, ductile, tenacious, opaque, yellow, soluble in *aqua regia*, &c. Now, let any one suppose for an instant that gold is deprived of all these, and becomes neither heavy, ductile, tenacious, opaque, yellow, soluble, &c. what remains, will it be gold? Certainly not. If it have other

properties, it is another substance. If it have no properties remaining, it is nothing. For nothing is that which hath no properties. Therefore, if any thing lose all its properties, it becomes nothing; that is, it loses its existence. Now, the existence of the soul is inferred, like the existence of every thing else, from its supposed properties, which are the phenomena of thinking, such as perception, recollection, judgment, and volition. But in all cases of *perfect* sleep, of the operation of a strong narcotic, of apoplexy, of swooning, of drowning where the vital powers are not extinguished, of the effects of a violent blow on the back part of the head, and all other leipothymic affections, there is neither perception, recollection, judgment, nor volition; that is, all the properties of the soul are gone, are extinguished. Therefore, the soul itself loses its existence for the time. If any man shall say, that these properties are only *suspended* for the time, I would desire him to examine what idea he annexes to this suspension; whether it be not neither more nor less than that *they are made not to exist for the time*. Either no more is meant, or it is contradictory to matter of fact; and moreover, if more be meant, it may easily be perceived to involve the archetypal existence of abstract ideas, and to contradict the axiom, *impossibile est idem esse et non esse*."

For the benefit of short-sighted inquirers, it is to be wished that the author had favoured the public with this *proof* which might have been so easily brought; for we can discern no connection whatever between the suspension of the exercise of the powers of the mind, and the archetypal existence of abstract ideas, or the absurd proposition that it is *possible for the same thing to be and not be*. We think, however, that we understand enough of this reasoning which he has given us to be able to pronounce with some confidence that it is nothing to the purpose. For, in the *first* place, we beg leave to observe, that between the properties of gold and the powers of thinking, &c. there is no similarity; and that what may be true when affirmed of the one, may be false when affirmed of the other. The powers of the mind are all more or less active; the enumerated properties of gold are all passive. We know by the most complete of all evidence, that the exercise of power *may be* suspended, and the power itself remain unimpaired; but to talk of the suspension of the energies of what was never energetic, if it be not to contradict the axiom *impossibile est idem esse et non esse*, is certainly to employ words which have no meaning. Yet even this argument from the properties of gold might have led the author to suspect that something else may be meant by the suspension of the exercise of powers, than that *those powers are made not to exist for the time*. In a room perfectly dark gold is not yellow; but does it lose any of its essential properties, and become a different substance, merely by being carried from light to darkness? Is a man while in a dark room deprived of the faculty of sight, and one of the powers of his mind made not to exist for the time? The author will not affirm that either of these events takes place. He will tell us that gold exhibits not its yellow appearance, merely because the proper medium of light passes not from it to the eye of the percipient, and that it is only for want of the same medium that nothing is seen by us in perfect darkness. Here,

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then, by his own confession, is a power of the mind, and a property of an external object, both suspended in their energies, without being annihilated; and no proof has yet been brought that all the powers of the mind may not in the same manner be suspended in their energies without being made not to exist. As light is necessary to vision, but is not itself either the thing which sees or the thing which is seen; so may the brain be necessary to the phenomena of thinking, without being either that which thinks, or that which is thought upon: and as actual vision ceases when light is withdrawn, though the eye and the object both continue to exist; so may the *energy* of thinking cease when the brain is rendered unfit for its usual office, though the being which thinks, and the power of thought, continue to exist, and to exist unimpaired. That this is actually the case every man must be convinced who believes that in thinking he exerts the same powers to-day that he exerted yesterday; and therefore our author's second demonstration of the non-existence of mind is, like his first, founded upon assertions which cannot be granted.

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Another of these pretended demonstrations is as follows: "If the soul exist at all, it must exist somewhere; for it is impossible to frame to one's self an idea of any thing existing, which exists no where. But if the soul exist somewhere, by the terms it occupies space, and therefore is extended; but whatever has extension, has figure in consequence thereof. The soul then, if it exist, hath the properties of extension and figure in common with matter. Moreover, by the supposition of every immaterial hypothesis (except those of Malbranche, Berkeley, and Leibnitz), it acts upon body, *i. e.* upon matter; that is, it attracts and repels, and is attracted and repelled, for there is no conceivable affection of matter but what is founded on its properties of attraction and repulsion; and if it be attracted and repelled, its re-action must be attraction and repulsion. The soul then has the properties of extension, figure, attraction, and repulsion, or solidity. But these comprise every property which matter, as such, has ever been supposed to possess. Therefore the soul is matter, or material. But by the supposition it is immaterial; therefore it does not exist. For nothing can exist whose existence implies a contradiction."

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Mr Cooper, we see, still proceeds in the direct road of mathematical demonstration; but in the present instance we beg leave to stop him in the very beginning of his course, and to ask *where* the universe exists? When he shall have given such an answer to this question as men of common sense may be able to comprehend, we may perhaps attempt to tell him where an unextended soul exists. If this demonstration be not a collection of words without meaning, the existence of space as a real thing is taken for granted. Space, therefore, has extension, and of course figure; but we believe Mr Cooper will find some difficulty in ascertaining the figure of infinite space. The mind certainly acts upon body. For this we have the evidence of consciousness and experience; but we have no evidence whatever that it must therefore attract and repel, and be attracted and repelled. It has been already observed, that the mind, whatever be its substance, acts upon the body by energies of will. What these are every man knows with the utmost certainty and preci-

sion, whilst we may venture to assert that no man knows precisely what corpuscular attraction and repulsion are, supposing the existence of such powers to be possible. When we speak of attraction and repulsion, we have some obscure notion of bodies acting upon each other at a distance; and this is all that we know of the matter. But when we think of an energy of the human will, the idea of distance neither enters nor can enter into our notion of such an energy. These are facts which we pretend not to prove by a mathematical or a chemical process. Every man must be convinced of their truth by evidence more complete than any proof, *viz.* immediate consciousness of his own thoughts and volitions. This being the case, we may turn Mr Cooper's artillery against himself, and, because mind acts upon body by powers different from attraction and repulsion, argue that body neither attracts nor repels; and were it true, as it is certainly false, that nothing could act upon another but by means of some property common to both, we might infer that every atom of matter is endowed with the powers of volition and intelligence, and by consequence that every man is not one but ten thousand conscious beings, a conclusion which our philosopher seems not inclined to admit.

Having finished his *demonstrations*, the author states other objections to the doctrine of immaterialism, which, as they are not his own nor new, have greater weight. "It appears no more than reasonable (says he), that if the doctrine of materialism be rejected as inadequate to explain the phenomena, these latter should at least be explained in some manner or other better upon the *substituted* than the *rejected* hypothesis; so that it is reasonable to require of an immaterialist that his supposition of a distinct soul should explain the *rationale* of the phenomena of thinking. But, strange to say, so far from attempting to explain these phenomena on the immaterial hypothesis, it is acknowledged on all hands that even on this hypothesis the phenomena are inexplicable." This objection it would certainly be no difficult task to obviate; but from that trouble, small as it is, we are happily exempted by the objector. "I would have it understood (says he), that no materialist ever undertook to say *how* perception results from our organization. What a materialist undertakes to assert is, that perception, *whatever* it be, or *however* it results from, does actually result from our organization." According to Mr Cooper, then, the *rationale* of thinking is equally inexplicable by materialists and immaterialists; and the truth is, that we know the *rationale* of hardly any one operation in nature. We see that the stroke of a racket produces motion in a billiard ball; but how it does so, we believe no man can say. Of the fact, however, we are certain; and know that the motion is produced by some power, about the effects of which we can reason with precision. In like manner we know with the utmost certainty, that we ourselves have the powers of perception and volition; and that these powers cannot be conceived as either an ell or an inch long. How they result from the mutual agency of an immaterial and material substance upon each other, we are indeed profoundly ignorant; but that such is the fact, and that they are not the result of mere organisation, we must necessarily believe, so long as it is true that the power of the entire system is nothing more than

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the sum or aggregate of the powers of all its parts. The immaterial hypothesis contains in it something inexplicable by man: The material hypothesis likewise contains, by the confession of its advocates, something that is equally inexplicable; and is over and above burdened with this contradiction, that the whole is something different from all its parts. It is therefore no "singular phenomenon in literary history, that one hypothesis should be rejected as inadequate to account for appearances, and that the hypothesis substituted should, even by the acknowledgement of its abettors, be such as not only not to explain the *rationale* of the appearances, but, from the nature of it, to preclude all hopes of such an explanation." This is exactly the case with respect to a *vacuum* in astronomy. That hypothesis does not in the least tend to explain the rationale of the motions of the planets; but yet it must be admitted in preference to a *plenum*, because upon this last hypothesis motion is impossible.

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"Supposing the existence of the soul, it is an unfortunate circumstance (says Mr Cooper), that we cannot properly assert positively any thing of it at all." Were this the case, it would indeed be a very unfortunate circumstance; but can we not assert positively as many things of the soul as we can of the body? Can we not say with as much propriety and certainty, that the soul has the powers of perception and volition, &c. as that the body is solid and extended, or as that matter has the powers of attraction and repulsion? We know perfectly what perception and volition are, though we cannot have *ideas* or mental images of them; and if our author knows what attraction and repulsion are, we believe he will not pretend to have of them ideas entirely abstracted from their objects. "But granting the soul's existence, it may be asked (says he), Of what use is an hypothesis of which no more can be asserted than its existence?" We have just observed, that much more can be asserted of the soul than its existence, viz. that it is something of which perception and will are properties; and he himself asserts nothing of matter but that it is something of which attraction and repulsion are properties.

"This soul, of which these gentlemen (the immaterialists) are conscious, is immaterial essentially. Now, I deny (says our author), that we can have any idea at all of a substance purely immaterial." He elsewhere says, that nothing can exist which is not extended, or that extension is inseparable from our notions of existence. Taking the word *idea* in its proper sense, to denote that appearance which external objects make in the imagination, it is certainly true that we can have no *idea* of an immaterial substance; but neither have we, in that sense, any idea of matter abstracted from its qualities. Has Mr Cooper any *idea* of that which attracts and repels, or of attraction and repulsion, abstracted from their objects? He may, perhaps, have, though we have not, very adequate ideas of bodies acting upon each other at a distance; but as he takes the liberty to substitute assertions for arguments, we beg leave in our turn to assert, that those ideas neither are, nor can be, more clear and adequate than our notion of perception, consciousness, and will, united in one being.

That extension is no otherwise inseparable from our

notions of existence than by the power of an early and perpetual association, is evident from this circumstance, that, had we never possessed the senses of sight and touch, we never could have acquired any idea at all of extension. No man, who has thought on the subject, will venture to affirm, that it is absolutely impossible for an intelligent being to exist with no other senses than those of smell, taste, and hearing. Now it is obvious that such a being must acquire some notion of existence from his own consciousness: but in-
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Extension |
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to that notion extension could not possibly enter; for neither sounds, tastes, smells, nor consciousness, are extended; and it is a fundamental article of the materialists creed, that all our ideas are relicts of sensation. Since then existence may be conceived without extension, it may be inferred that they are not inseparable from each other; and since cogitation cannot be conceived with extension, we may reasonably conclude that the being which thinks is not extended.

Mr Cooper indeed with his master talks of extended ideas and extended thoughts: but we must assert, in the words of Cudworth, that "we cannot conceive a *thought* to be of such a certain *length, breadth, and thickness*, measurable by *inches, feet, and yards*; that we cannot conceive the *half, or third, or twentieth* part of a thought; and that we cannot conceive every thought to be of some determinate *figure*, such as *round or angular, spherical, cubical, cylindrical*, or the like. Whereas if extension were inseparable from existence, *thoughts* must either be mere *non-entities*, or extended into *length, breadth, and thickness*; and consequently all truths in us (being nothing but complex thoughts) must be long, broad, and thick, and of some determinate figure. The same must likewise be affirmed of volitions, appetites, and passions, and of all other things belonging to cogitative beings; such as knowledge and ignorance, wisdom and folly, virtue and vice, &c. that these are either all of them absolute *non-entities*, or else extended into three dimensions, and measurable not only by *inches* and *feet*, but also by solid measures, such as *pints* and *quarts*. But if this be absurd, and if these things belonging to soul and mind (though doubtless as great realities at least as the things which belong to body) be *unextended*, then must the substances of souls or minds be themselves unextended, according to that of Plotinus, *Νοὺς οὐ διασπαστὸς ἀπὸ τῶν σώματων*, and therefore the human soul cannot be material."

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Mr Cooper employs many other arguments to prove the materiality of the sentient principle in man; but the force of them extends no farther than to make it in the highest degree probable, that the mind cannot exert its faculties but in union with some organised corporeal system. This is an opinion which we feel not ourselves inclined to controvert; and therefore we shall not make any particular remarks upon that part of our author's reasonings. That an immaterial and indiscerptible being, such as the soul, is not liable to be *dissolved* with the body, is a fact which cannot be controverted: for what has no parts can perish only by *annihilation*; and of annihilation the annals of the world afford no instance. That an immaterial being, endowed with the powers of perception and volition, &c. may be capable of exerting these powers in a state of separation from all body, and that at least one immaterial Being does actually so exert them, or other powers analogous to them, are truths which no man

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whose arrogance does not surpass his judgment will venture to deny; but the question at present between the most rigid immaterialists and their opponents, is, whether there is ground to think that the human soul is such a being?

Now, when Mr Baxter and his followers confidently affirm, that human perception must necessarily subsist after the dissolution of the present mortal and perishable system; and that the soul, when disencumbered of all body, will have its faculties greatly enlarged; they affirm what to us appears incapable of proof. That a disembodied soul may perceive, and think, and act, and that its powers of intellection may have a wider range than when they were circumscribed by a corporeal system, which permitted their action upon external objects only through five organs of sense, is certainly possible; and the argument by which the materialists pretend to prove it not possible, is one of the most contemptible sophisms that ever disgraced the page of philosophy. To affirm, that because our intellectual powers, in their embodied state, seem to decay with the system to which they are united, the mind, when set free, must therefore have no such powers at all, is equally absurd as to say, that because a man shut up in a room which has but one window sees objects less and less distinctly as the glass becomes more and more dimmed, he must in the open air be deprived of the power of vision. But because the human soul may, for any thing that we see to the contrary, subsist, and think, and act, in a separate state, it does not therefore necessarily follow that it will do so; and every thing that we know of its nature and its energies leads us to think, that without some kind of body by which to act as by an instrument, all its powers would continue dormant. There is not the shadow of a reason to suppose that it existed and was conscious in a prior state; and as its memory at present unquestionably depends upon the state of the brain, there is all the evidence of which the case will admit, that if it should subsist in a future state divested of all body, though it might be endowed with new and enlarged powers of perception, it could have no recollection of what it did and suffered in this world, and therefore would not be a fit object either of reward or of punishment. This consideration has compelled many thinking men, both Pagans and Christians, to suppose that at death the soul carries with it a fine material vehicle, which is its immediate sensorium in this world, and continues to be the seat of its recollection in the next. Such, we have seen, was the opinion of Mr Wollaston and Dr Hartley; it was likewise the opinion of Cudworth and Locke, who held that the supreme Being alone is the only mind wholly separated from matter; and it is an opinion which even Dr Clarke, one of the ablest advocates for immaterialism, would not venture positively to deny.

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Ancient.

Nor is this opinion peculiar to a few moderns. Cudworth, after giving a vast number of quotations from Pythagoreans and Platonists, which prove to a demonstration that they held the Deity to be the only mind which perceives and acts without the instrumentality of matter, observes, that "from what hath been said, it appeareth, that the most ancient assertors of the incorporeity and immortality of the human soul, yet

supposed it to be always conjoined with some body. Of the Substance of the Human Mind. Thus Hierocles plainly ἡ λογικὴ οὐσία συμφοῖς ἔχουσα σῶμα, οὐκ ἔστι παρὰ τοῦ δημιουργοῦ εἰς τὸ εἶναι παρηλθὲν, ὥς μήτε τὸ σῶμα εἶναι αὐτὴν, μήτε ἀνεῦ σώματος· ἀλλ' αὐτὴν μὲν ἀσώματον, ἀποπύρρῃ τούτοις δὲ εἰς σῶμα τὸ ὅλον αὐτῆς εἶδος. The rational nature having always a kindred body, so proceeded from the demiurgus; as that neither itself is body, nor yet can it be without body; but though itself be incorporeal, yet its whole form is terminated in a body. Agreeably to this the definition which he gives of a man is, ψυχὴ λογικὴ μετὰ συμφοῦς ἀθανάτου σώματος, a rational soul, together with a kindred immortal body; and he affirms, that our present animated terrestrial body, or mortal man, is nothing but εἰδωλὸν ἀνθρώπου, the image of the true man, or an accession from which it may be separated. Neither does he affirm this only of human souls, but also of all other rational beings whatsoever below the supreme Deity, that they always naturally actuate some body. Wherefore a demon or angel (which by Hierocles are used as synonymous words), is also defined by him after the same manner, ψυχὴ λογικὴ μετὰ φωτεινοῦ σώματος a rational soul, together with a lucid body. And accordingly Proclus upon Plato's Timæus affirmeth, πάντα δαιμόνια τῶν ἡμετέρων κρείσσονα ψυχῶν, καὶ νοερὰν ἔχειν, ψυχὴν, καὶ οὐχ ἡμαίριον: That every demon, superior to human souls, hath both an intellectual soul and an æthereal vehicle, the entireness thereof being made up or compounded of these two things. So that there is hardly any other difference left between demons or angels, and men, according to these philosophers, but only this, that the former are lapsable into aerial bodies only, and no further; but the latter into terrestrial also. Now, Hierocles positively affirms this to have been the true cabala, and genuine doctrine of the ancient Pythagoreans, entertained afterwards by Plato: καὶ τοῦτο τῶν Πυθαγορείων ἦν δόγμα, ὃ δὲ Πλάτων ὑπερὸν ἐξήρηνεν, ἀπεικάζας θυμφοτῶν δυνάμει ὑποπτερου θυμῷ τε καὶ ἡνιόχῳ; πᾶσαν εἶαν τε καὶ ἀνθρώπινην ψυχὴν. And this was the doctrine of the Pythagoreans, which Plato afterwards declared; he resembling every both human and divine soul (i. e. in our modern language, every created rational being) to a winged chariot, and a driver or charioteer both together: meaning by the chariot, an animated body; and by the charioteer, the incorporeal soul actuating it.

That this Pythagorean opinion of the Deity's being the only mind which thinks and acts without material organs was very generally received by the ancient Christians, might be proved by a thousand quotations: We shall content ourselves with producing two from the learned Origen. "Solius Dei (saith this philosophic father of the church), id est, Patris, Filii, et Spiritus Sancti, naturæ id proprium est, ut sine materiali substantia, et absque ulla corporeæ adjectionis societate, intelligatur subsistere†." "Materialem substantiam opinione quidem et intellectu solum separari, a naturis rationalibus, et pro ipsis, vel post ipsis affectam videri; sed nunquam sine ipsa eas vel vixisse, vel vivere: Solius namque Trinitatis incorporea vita existere putabitur†." Should Mr Cooper and his friends ask, What is the use of a soul which cannot act without the instrumentality of matter? or why we should suppose the existence of such a substance? we beg leave, in our turn, to ask these gentlemen, What is the use of a brain which cannot see without eyes?

† Peri Ar-
chōn, lib. 1.
cap. 6.

† Lib. 2.
cap. 2.

Of Personal Identity.

and why they should suppose all our sensations to terminate in such an internal system, since the vulgar certainly suppose their sensations to subsist in their respective organs? How this ancient notion, which makes body so essential a part of man, is consistent with the immortality of the human soul, we shall inquire in a subsequent chapter; in which we shall endeavour to ascertain what kind of immortality we have reason to expect, and upon what evidence our expectation must rest. Previous to this inquiry, however, it is necessary to enter upon another, which is of the first importance, and which every materialist has endeavoured to perplex; we mean that which concerns *personal identity*: for if, as has been often said, no man is the same person two days successively, it is of no importance to us whether the soul be mortal or immortal.

CHAP. III. OF PERSONAL IDENTITY.

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Personal identity,

WHETHER we are to live in a future state, as it is the most important question which can possibly be asked, so is it the most intelligible one which can be expressed in language. Yet strange perplexities have been raised about the meaning of that identity or sameness of person, which is implied in the notion of our living now and hereafter, or indeed in any two successive moments; and the solution of these difficulties hath been stranger than the difficulties themselves. To repeat all that has been said on the subject would swell this chapter to a disproportionate bulk. We shall therefore content ourselves with laying before our readers the sentiments of Bishop Butler, and the fancies and demonstrations of the philosopher of Manchester. We are induced to adopt this course, because we think the illustrious Bishop of Durham has exhausted the subject, by stating fairly the opinions which he controverts, and by establishing his own upon a foundation which cannot be shaken, and which are certainly not injured, by the objections of Mr Cooper.

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though it cannot be defined, easily understood and ascertained by consciousness and memory.
† *Dissertation 1st, subjoined to the Analogy of Religion, &c.*

“When it is asked (says this philosophical prelate†) in what personal identity consists? the answer should be the same as if it were asked in what consists similitude or equality?—that all attempts to define would but perplex it. Yet there is no difficulty at all in ascertaining the idea or notion: For as, upon two triangles being compared or viewed together, there arises to the mind the notion of similitude; or, upon twice two and four, the notion of equality: so likewise, upon comparing the consciousness of one’s self or one’s own existence in any two moments, there as immediately arises to the mind the notion of personal identity. And as the two former comparisons not only give us the notions of similitude and equality, but also show us that two triangles are similar, and that twice two and four are equal; so the latter comparison not only gives us the notion of personal identity, but also shows us the identity of ourselves in these two moments—the present, suppose, and that immediately past, or the present and that a month, a year, or twenty years past. In other words, by reflecting upon that which is myself now, and that which was myself twenty years ago, I discern they are not two, but one and the same self.

“But though consciousness of what is present and

remembrance of what is past do thus ascertain our personal identity to ourselves; yet, to say that remembrance makes personal identity, or is necessary to our being the same persons, is to say that a person has not existed a single moment, nor done one action, but what he can remember; indeed none but what he reflects upon. And one should really think it self-evident, that consciousness of personal identity presupposes and therefore cannot constitute personal identity; any more than knowledge, in any other case, can constitute truth, which it presupposes.

“The inquiry, what makes vegetables the same in the common acceptation of the word, does not appear to have any relation to this of personal identity; because the word *same*, when applied to them and to person, is not only applied to different subjects, but is also used in different senses. When a man swears to the same tree, as having stood fifty years in the same place, he means only the same as to all the purposes of property and uses of common life, and not that the tree has been all that time the same in the strict philosophical sense of the word: For he does not know whether any one particle of the present tree be the same with any one particle of the tree which stood in the same place fifty years ago. And if they have not one common particle of matter, they cannot be the same tree in the proper and philosophic sense of the word *same*; it being evidently a contradiction in terms to say they are, when no part of their substance and no one of their properties is the same; no part of their substance, by the supposition; no one of their properties, because it is allowed that the same property cannot be transferred from one substance to another: And therefore, when we say that the identity or sameness of a plant consists in a continuation of the same life, communicated under the same organization to a number of particles of matter, whether the same or not; the word *same*, when applied to life and to organization, cannot possibly be understood to signify what it signifies in this very sentence, when applied to matter. In a loose and popular sense, then, the life, and the organization, and the plant, are justly said to be the same, notwithstanding the perpetual change of the parts. But, in a strict and philosophical manner of speech, no man, no being, no mode of being, no any thing, can be the same with that with which it has indeed nothing the same. Now sameness is used in this latter sense when applied to persons. The identity of these, therefore, cannot subsist with diversity of substance.

“The thing here considered, and demonstratively, as I think, determined, is proposed by Mr Locke in these words: *Whether it (i. e. the same self or person) be the same identical substance?* And he has suggested what is a much better answer to the question than that which he gives it in form: For he defines person *a thinking intelligent being, &c.* and personal identity, *the sameness of a rational being*; and then the question is, *Whether the same rational being is the same substance?* which needs no answer; because being and substance are in this place synonymous terms. The ground of the doubt, whether the same person be the same substance, is said to be this, that the consciousness of our own existence, in youth and in old age, or in any two joint successive moments, is not *the same individual action*.

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What it is.

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i. e. not the same consciousness, but different successive consciousnesses. Now it is strange that this should have occasioned such perplexities: for it is surely conceivable, that a person may have a capacity of knowing some object or other to be the same now which it was when he contemplated it formerly; yet in this case, where, by the supposition, the object is perceived to be the same, the perception of it in any two moments cannot be one and the same perception. And thus, though the successive consciousnesses which we have of our own existence are not the same, yet are they consciousnesses of one and the same thing or object; of the same person, self, or living agent. The person of whose existence the consciousness is felt now, and was felt an hour or a year ago, is discerned to be, not two persons, but one and the same person; and therefore is one and the same.

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False notions of
personal
identity

"Mr Locke's observations upon this subject appear hasty; and he seems to profess himself dissatisfied with suppositions which he has made relating to it. But some of those hasty observations have been carried to a strange length by others; whose notion, when traced and examined to the bottom, amounts, I think, to this: 'That personality is not a permanent but a transient thing: That it lives and dies, begins and ends, continually: That no one can any more remain one and the same person two moments together, than two successive moments can be one and the same moment: That our substance is indeed continually changing: but whether this be so or not is, it seems, nothing to the purpose; since it is not substance, but consciousness alone, which constitutes personality; which consciousness, being successive, cannot be the same in any two moments, nor consequently the personality constituted by it.' Hence it must follow, that it is a fallacy upon ourselves to charge our present selves with any thing we did, or to imagine our present selves interested in any thing which befel us, yesterday; or that our present self will be interested in what will befall us to-morrow; since our present self is not in reality the same with the self of yesterday, but another self or person coming in its room, and mistaken for it; to which another self will succeed to-morrow. This, I say, must follow: for if the self or person of to-day and that of to-morrow are not the same, but only like persons; the person of to-day is really no more interested in what will befall the person of to-morrow, than in what will befall any other person. It may be thought, perhaps, that this is not a just representation of the opinion we are speaking of; because those who maintain it allow that a person is the same as far back as his remembrance reaches: And indeed they do use the words *identity* and *same person*; nor will language permit these words to be laid aside. But they cannot, consistently with themselves, mean that the person is really the same: For it is self-evident, that the personality cannot be really the same, if, as they expressly assert, that in which it consists is not the same. And as, consistently with themselves, they cannot, so I think it appears they do not, mean that the person is *really* the same, but only that he is so in a fictitious sense, in such a sense only as they assert: for this they do assert, that any number of persons whatever may be the same person. The bare unfolding this notion, and laying it thus naked and open,

N^o 215.

seems the best confutation of it. However, since great stress is laid to be put upon it, I add the following things:

"*First*, This notion is absolutely contradictory to that certain conviction, which necessarily and every moment rises within us, when we turn our thoughts upon ourselves, when we reflect upon what is past, and look forward to what is to come. All imagination, of a daily change of that living agent which each man calls himself for another, or of any such change throughout our whole present life, is entirely borne down by our natural sense of things. Nor is it possible for a person in his wits to alter his conduct with regard to his health or affairs, from a suspicion that though he should live to-morrow he should not however be the same person he is to day.

"*Secondly*, It is not an *idea*, or abstract notion, or quality, but a being only which is capable of life and action, of happiness and misery. Now all beings confessedly continue the same during the whole time of their existence. Consider then a living being now existing, and which has existed for any time alive: this living being must have done, and suffered, and enjoyed, what it has done, and suffered, and enjoyed, formerly (this living being, I say, and not another), as really as it does, and suffers, and enjoys, what it does, and suffers, and enjoys, this instant. All these successive actions, sufferings, and enjoyments, are actions, enjoyments, and sufferings, of the same living being; and they are so prior to all considerations of its remembering or forgetting, since remembering or forgetting can make no alteration in the truth of past matter of fact. And suppose this being endued with limited powers of knowledge and memory, there is no more difficulty in conceiving it to have a power of knowing itself to be the same being which it was some time ago, of remembering some of its actions, sufferings, and enjoyments, and forgetting others, than in conceiving it to know, or remember, or forget, any thing else.

"*Thirdly*, Every person is conscious that he is now the same person or self he was as far back as his remembrance reaches: since when any one reflects upon a past action of his own, he is just as certain of the person who did that action, namely himself (the person who now reflects upon it), as he is certain that the action was at all done. Nay, very often a person's assurance of an action having been done, of which he is absolutely assured, arises wholly from the consciousness that he himself did it: and this he, person, or self, must either be a substance or the property of some substance. If *he*, if person, be a substance; then consciousness that he is the same person, is consciousness that he is the same substance. If the person, or *he*, be the property of a substance, still consciousness that he is the same property is as certain a proof that his substance remains the same, as consciousness that he remains the same substance would be; since the same property cannot be transferred from one substance to another.

"But though we are thus certain that we are the same agents, living beings, or substances, now, which we were as far back as our remembrance reaches; yet it is asked, Whether we may not possibly be deceived in it? And this question may be asked at the end of any demonstration whatever; because it is a question

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§ Answer to
Dr Clarke's
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fence of his
Letter to
Mr Dod-
well, second
edit. p. 44,
56, &c.

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Of Personal Identity. concerning the truth of perception by memory : and he who can doubt whether perception by memory can in this case be depended upon, may doubt also whether perception by deduction and reasoning, which also include memory, or indeed whether intuitive perception itself, can be depended upon. Here then we can go no farther : for it is ridiculous to attempt to prove the truth of our faculties, which can no otherwise be proved than by the use or means of those suspected faculties themselves."

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Objections to the foregoing reasoning.
* Tracts, &c.
This reasoning, which we believe will to most men appear unanswerable, Mr Cooper hopes to overturn by the following observations * : " If all imagination of a daily change in us be borne down by our natural sense of things, then (says he) does our natural sense of things positively contradict known fact ; for a daily, a momentaneous, change in us, *i. e.* in our bodies, does actually take place." True, a daily change in our bodies does take place, and so likewise does a daily change in our cloaths ; but surely no man was ever led by his natural sense of things to suppose, that his limbs or external organs were the seats of sensation and will, any more than that his coat or his shoes were any real parts of his trunk or of his feet. But it is only that which thinks and wills that any man considers, in this case, as himself or his person ; and if our natural sense of things, or consciousness, tell us, that what thinks and wills has continued the same from a distance of time as far back as we can remember, it is certain, that, whether it be material or immaterial, it has continued from that period, otherwise we can be certain of nothing. " But (says our philosopher) other known and ascertained facts are frequently borne down by our natural sense of things : for how many thousand years before the days of *Copernicus* was the motion of the earth round the sun entirely borne down by our natural sense of things, which made us give full credit to the motion of the sun round the earth ? Do not the generality of mankind believe, upon the evidence of their natural sense of things, that every part of their body remains exactly the same to-day as it was yesterday ?"

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Answered. To the former of these questions we answer positively, that before the days of *Copernicus* the motion of the earth round the sun was *not* borne down by our *natural sense* of things, but by ill-founded hypotheses and inconclusive reasonings. By the natural sense of things, nothing can be meant, in this place, but the evidence of consciousness or of external sensation ; but the *actual motion* either of the sun or of the earth is not perceived either by consciousness or by sensation. Of consciousness nothing is the object but the internal energies and feelings of our own minds ; and with regard to the motion of the sun or of the earth, nothing is perceived by the sense of sight but that, after considerable intervals of time, these two great bodies have repeatedly changed their places in the heavens with respect to each other. This is all that on this subject our *natural sense of things* leads us to believe ; and is not

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this infallibly true ? Afterwards indeed, by taking for granted the truth of propositions, for which neither sense nor consciousness affords the shadow of evidence ; the vulgar now, and all mankind formerly, reasoned themselves into the opinion, that the earth stands still, and that the sun moves round it. In vulgar philosophy it is taken for granted, that in the universe there is not a *relative* but an *absolute upwards* and an *absolute downwards* ; that our heads are absolutely upward, and our feet downward ; and that were the earth to revolve round its axis, these positions would be reversed, that our heads would be placed beneath our feet, and that we ourselves would fall from the earth into empty space. Upon these false hypotheses the vulgar reason correctly. They know that bodies cannot change their place without motion ; they know that in the time of their remembrance the sun and the earth have been perpetually varying their places with respect to each other ; they know that they themselves have never fallen, nor had a tendency to fall, into empty space ; and hence they infer that it is the sun and not the earth that moves (κ). But will any man say that the absurd suppositions from which this conclusion is logically deduced, have the evidence either of sensation or of consciousness, as the permanency of that living agent which each man calls himself has ?

To our author's second question we likewise reply with confidence, that the generality of mankind do *not* believe, upon their natural sense of things, that every part of their body remains exactly the same to-day as it was yesterday. It would be strange indeed if they did, after having repeatedly experienced the waste of increased perspiration or sweating ; after having witnessed men emaciated by sickness, and again restored to plumpness in health ; and after having perhaps lost whole limbs, which certainly their natural sense of things teaches them to consider as parts of their body. In all these cases, the generality of mankind are as sensible of changes having taken place in their bodies as he who has attended ever so closely to physiological inquiries, though not one of them has the least imagination of a change having taken place in the living agent which each man calls himself.

Bishop Butler observes, that if the living agent be perpetually changing, it is a fallacy upon ourselves to charge our present selves with any thing we did, to imagine our present selves interested in any thing which befel us yesterday, or that our present self will be interested in what will befall us to-morrow. To this judicious observation our daring philosopher replies, " that as the man of to-morrow, though not in all points the same with, yet depends for his existence upon, the man of to-day, there is sufficient reason to care about him." Could he have said, that as the man of to-day depends for his existence on the man of to-morrow, there is sufficient reason for the present man to care about the future man ; or that as the man of to-morrow depends for his existence on the man of to-day,

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(κ) This inference too has been so often drawn, that it comes in time to coalesce in the mind with the *sensations*, from which the motion either of the sun or of the earth is deduced with infallible certainty ; and hence it is considered as part of that truth which sensation immediately discovers. See our Chapter of ASSOCIATION.

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Identity

day, there is to-day sufficient reason for the future man to care about the present man; we should in either case, if the anachronism had been kept out of sight, have seen the force of his argument. Every man has sufficient reason to care about the ox upon which he is to be fed; but we cannot so clearly perceive what reason the ox has to care about the man.

Not satisfied, it would seem, with this reply, our author proceeds to affirm, "that the man of to-morrow, possessing a reminiscence of the actions of the man of to-day, and knowing that these actions will be referred to him both by himself and others (which is certainly knowing that both himself and others are most iniquitous wretches), they cannot be indifferent to the man of to-day, who looks forward to the properties of the man of to-morrow;" i. e. the reminiscence and knowledge of a future man constitute all the relation that subsists between a present man and his actions; a discovery worthy of an original genius. But as on the subject of personal identity we pretend to no originality, we shall leave this proposition to the meditation of our readers, and take the liberty to ask our author a question or two respecting this same reminiscence, which he is graciously pleased to acknowledge for a property.

He defines identity, "the continued existence of any being unaltered in substance or in properties;" and he repeatedly acknowledges that no identical quality or property can be transferred from one subject to another. Let us now suppose, that a man has a reminiscence of an individual action performed a month ago, and that this reminiscence is accompanied with a consciousness that the action was performed by himself. This supposition, whether true or false, may certainly be made; for it implies nothing more than what every man firmly believes of himself in every act of remembrance. Let us again suppose, that, at the distance of ten or twenty years, the man known by the same name has a reminiscence of the same action, with a consciousness that he himself performed it. Is this reminiscence the same with the former? or is it a different reminiscence? If it be the same, either the person remembering at the distance of ten or twenty years is the same with him who remembered at the distance of a month, or there is an identical quality transferred from one substance to another, which is admitted to be impossible. If reminiscence be itself a real and immediate quality of any substance, and not the mere energy of a power, and if the one reminiscence be different from the other, the subjects in which these two different qualities inhere must likewise be different. Yet the man who has the reminiscence at the distance of a month, has the evidence of consciousness that the action was performed by him; and the man who has the reminiscence at the distance of ten or twenty years, has likewise the evidence of consciousness that the same action was performed by him and not by another. By the confession of Hume and of all philosophers, consciousness never deceives; but here is the evidence of one consciousness in direct opposition to another; and therefore, as two contradictory propositions cannot both be true, either the one reminiscence is the same with the other, or reminiscence is no real quality. That one act of reminiscence should be numerically the same with another, which followed

it at the distance of twenty years, is plainly impossible; whence it should seem, that reminiscence itself is no real and immediate quality of any substance. But if this be so, what is reminiscence? We answer, it is plainly neither more nor less than the *energy* of a power, which though dormant between its energies, remains unchanged from the one to the other, and which being itself the real and immediate quality of a subject, that subject must likewise remain unchanged. That powers may remain dormant, and yet unchanged, every man must be convinced; who having struck any thing with his hand, knows that he has power to repeat the stroke, and yet does not actually repeat it. Two blows with the hand immediately following each other are numerically different, so that the one cannot with truth be said to be the other; but we have the evidence of external sense, that they are both struck by the same member. In like manner, two energies of reminiscence directed to the same object, and succeeding each other at any interval of time, cannot possibly be one and the same energy; but as the latter energy may include in it the former as well as the object remembered by both, we have the evidence of consciousness that both are energies of the same power; and we have seen, that to suppose them any thing else, may be demonstrated to involve the grossest absurdities and contradictions.

Mr Cooper has other arguments to obviate the force of Bishop Butler's demonstration of personal identity; such as, that a "high degree of *similarity* between the two succeeding men is sufficient to make the one care about the other;" and, that "a good man, knowing that a future being will be punished or rewarded as the actions of the present man deserve, will have a sufficient motive to do right and to abstain from wrong." But if there be any one of our readers who can suffer himself to be persuaded by such assertions as these, that the living agent which he calls himself is perpetually changing, and at the same time that such change is consistent with the expectation of future rewards and punishments, he would not be reclaimed from his error by any reasoning of ours. We shall therefore trust such trifling with every man's judgment, and proceed to examine our author's *demonstration*, that personal identity has no existence. But here it is no part of our purpose to accompany him through his long chemical ramble, or to controvert his arguments for the non-identity of vegetable and animal bodies. The only thing to which, after Bishop Butler, we have ascribed identity, is that which in man is sentient and conscious; and the non-identity of this thing, whatever it be, Mr Cooper undertakes to demonstrate from the known properties of sensations and ideas.

This demonstration sets out with a very ominous circumstance. The author, after conducting impref-^{ed demon-}strations *ab extra*, from the extremities of the nerves to the brain, affirms, that *sensations* and *ideas* are nothing ^{that personal i-} but "motions in the brain perceived;" i. e. when ^{identity is} impossible a man thinks he is looking at a mountain, not only at rest, but to appearance immoveable, he is grossly deceived; for he perceives nothing all the while but *motion in his brain!* Were not the desire of advancing novelties and paradoxes invincible in some minds, we should be astonished at finding such an assertion as this

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this fall from the pen of any man who had paid the slightest attention to the different energies of his own intellect. Motions in the brain, as we have repeatedly observed, are the immediate causes of our sensations; but is it conceivable, is it possible, that any thing should be the cause of itself? The motion of a sword through the heart of a man, is the immediate cause of that man's death; but is the sword or its motion *death* itself, or can they be conceived as being the *sensations* of the man in the agonies of dying? But sensations and ideas, whatever they be, exist in succession; and therefore, argues our demonstrator, no two sensations or ideas can be one and the same sensation or idea. The conclusion is logically inferred; but what purpose can it possibly serve? What purpose, why it seems "sensations and ideas are the only *existences* whose existence we certainly know (a charming phrase, the *existence* of *existences*, and as original as the theory in which it makes its appearance); and, therefore, from the nature of sensations and ideas, there is no such thing as permanent identity." Indeed! what then, we may be permitted to ask, is the import of the word *we* in this sentence? Does it denote a series of sensations and ideas, and does each sensation and each idea certainly know not only itself, but all its ancestors and all its descendants? Unless this be admitted, we are afraid that some other existence besides sensations and ideas must be allowed to be certainly known, and even to have something of a permanent identity. Nay, we think it has been already demonstrated (see chap. of TIME), that were there not something permanent, there could be no time, and of course no notion of a first and last, or indeed of succession, whether of sensations or ideas. And therefore, if we have such a notion, which the author here takes for granted, and upon which indeed his demonstration rests, it follows undeniably that there is something permanent, and that we *know* there is something permanent, which observes the succession of sensations and ideas.

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Shown to
be absurd
and ridicu-
lous.

All this, indeed, Mr Cooper in effect grants; for he is not much startled at the appearance of contradictions in his theory. "I find (says he), by perpetually repeated impressions which I perceive, that my hands, body, limbs, &c. are connected, are parts of one whole. I find, by perpetually repeated perceptions also, that the sensations excited by them are constantly similar, and constantly different from the sensations excited by others." He has then repeated perceptions: but how can this be possible, if *he* be not different from the perceptions, and if *he* do not *remain unchanged* while the perceptions succeed each other at greater or less intervals of time? A striking object passing with rapidity before the eyes of a number of men placed beside each other in a line of battle, would undoubtedly excite a succession of sensations; but surely that succession would not take place in the mind of *any individual* in the line, nor could any *single man* in this case say with truth that he had *repeated* perceptions of the object. In like manner, were that which is sentient perpetually changing, no man could possibly say or suppose that he had repeated perceptions of any thing; for upon this supposition, the man of to-day would have no more

connection with the man who bore his name yesterday, or twenty years ago, than the last man in the line had with the first.

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Upon the whole, we cannot help thinking, that Bishop Butler's demonstration of personal identity remains unshaken by the batteries of Mr Cooper.—It rests, indeed, upon the solid basis of consciousness and memory; and if implicit credit be not given to the evidence of these faculties, we cannot proceed a single step in any inquiry whatever, nor be certain of the truth even of a mathematical demonstration.

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But as we have ourselves supposed, that to sensation, reminiscence, and every actual energy of the mind removed. A difficulty

of man, the instrumentality of some material system is necessary, it may perhaps be thought incumbent on us to show how the perpetual flux of the particles of matter which compose the brain, as well as all the other parts of the body, can consist with the identity of the person who perceives, remembers, and is conscious. If this cannot be done, our hypothesis, ancient and plausible as it is, must be given up; for of personal identity it is impossible to doubt. In this case, however, we perceive no difficulty; for if there be united to the brain an immaterial being, which is the subject of sensation, consciousness, and will, &c. it is obvious, that all the *intellectual powers* which properly constitute the person, must be inherent in that being. The material system, therefore, can be necessary only as an instrument to excite the energies of those powers; and since the powers themselves remain unchanged, why should we suppose that their energies may not be continually exerted by successive instruments of the same kind, as well as by one permanent instrument? The powers of perception and volition are not, in the material system, any more than the sensation of seeing is in the rays of light, or the energy of the blacksmith in the hammer with which he beats the anvil. Let us suppose a man to keep his eye for an hour steadily fixed upon one object. It will not surely be denied, that if this could be done, he would have one uninterrupted and unvaried perception of an hour's duration, as measured by the clock. Yet it is certain, that the rays of light which alone could occasion that perception would be perpetually changing. In like manner, a blacksmith, whilst he continues to beat his anvil, continues to exert the same power whether he uses one hammer all the time, or a different hammer at each stroke. The reason is obvious; the eye, with all its connections of brain and mind in the one case, and the person of the smith in the other, remain unchanged; and in them alone reside the faculty of sensation and the power of beating, though neither the faculty nor the power can be exerted without material instruments. But were it possible that millions of men could in the space of an hour take their turns in rotation with each new ray of light, it is self-evident, that in this case, there would be nothing permanent in sensation; and, therefore, there could not be one uninterrupted and unvaried perception, but millions of perceptions, during the hour, totally distinct from and unconnected with each other. Let us now suppose a man to fix his eye upon an object for the space of a minute, and at the distance of a day or a month to fix it upon the same object

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object a second time. He would not indeed, in this case, have one uninterrupted and unvaried perception, but he would be conscious of the energy of the very same faculty the second time as at the first. Whereas, were one man to view an object to-day, and another to view the same object to-morrow, it is obvious, that he who should be last in the succession could know nothing of the energy of that faculty by which the object was perceived the first day, because there would be nothing common to the two perceptions.

Thus then we see, that *personal identity* may with truth be predicated of a compound being, though the material part be in a perpetual flux, provided the immaterial part remain unchanged; and that of such a being only is a resurrection from the dead possible.—For since the motions of the brain do nothing more than excite to energy the permanent powers of the mind, it is of no sort of consequence to that energy, whether these motions be continued by the same numerical atoms, or by a perpetual succession of atoms arranged and combined in the very same manner. We shall, therefore, be the same persons at the resurrection as at present, whether the mind be united to a particular system composed of any of the numberless atoms which have in succession made parts of our present bodies, or to a system composed of totally different atoms, provided that new system be organised in exactly the same manner with the brain or material vehicle, which is at present the immediate instrument of perception. This (we say) is self-evident; but were the immaterial part to change with the changing body, a resurrection of the same persons would be plainly impossible.

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mortality of
the soul the
general be-
lief in all
nations.

WHEREVER men have been in any degree civilized, and in some nations where they have been in the most savage state, it has been the general persuasion, that the mind or soul subsists after the dissolution of the body. The origin of this persuasion, about which disputes have been raised, no Christian hesitates to attribute to revelation. The Egyptians, from whom the Greeks derived many of their theological and philosophical principles, appear to have taught the immortality of the soul, not as a truth discovered by the exertions of human reason, but as a dogma derived to them from the earliest ages by tradition. This indeed may be confidently inferred from the character and conduct of their first Greek disciples. Those early wise men who fetched their philosophy immediately from Egypt, brought it home as they found it, in detached and independent placits. Afterwards, when schools were formed, and when man began to philosophise by hypothesis and system, it was eagerly inquired upon what foundation in nature the belief of the soul's immortality could rest; and this inquiry gave rise to the various disquisitions concerning the *substance* of the soul, which have continued to exercise the ingenuity of the learned to the present day. It was clearly perceived, that if consciousness, thought, and volition, be the result of any particular modification of matter and motion, the living and thinking agent must perish with the dissolution of the system;

and it was no less evident, that if the being which perceives, thinks, and wills, be not material, the mind of man may subsist after the resolution of the body into its component particles. The discovery of the immateriality of the mind was therefore one *step towards* the proof of its immortality; and in the opinion of many philosophers, whose hopes ought to rest on a surer basis, it was alone a complete proof.—“They who hold sensitive perception in brutes (says a pious writer †) to be an argument for the immateriality of their souls, find themselves under the necessity of allowing those souls to be immortal.”

The philosophers of ancient Greece, however, felt not themselves under any such necessity. Whatever were their opinions respecting the souls of brutes, they clearly perceived that nothing which had a beginning of existence could be naturally immortal, whether its substance were material or immaterial.—“There never was any of the ancients before Christianity (says the accurate Cudworth), that held the soul's future permanency after death, who did not likewise assert its pre-existence; they clearly perceiving, that if it were once granted that the soul was generated, it could never be proved but that it might be also corrupted. And, therefore, the assertors of the soul's immortality commonly began here, first to prove its pre-existence, proceeding thence to establish its permanency after death. This is the method of proof used in Plato: *Ἡ ψυχὴ ἡμῶν ἢ ψυχὴ πρὶν ἐν τῷ δὲ τῷ ἀνθρώπῳ εἶδεν γενέσθαι, ὥστε καὶ ταύτην ἀθάνατον εἶναι τοῖς ἡμῶν ἢ ψυχῇ εἶναι.* Our soul was somewhere before it came to exist in this human form, and thence it appears to be immortal, and as such will subsist after death.”

To give this argument for immortality any strength, it must be taken for granted, not only that the soul existed in a *prior* state, but that it existed from all eternity; for it is obvious, that if it had a beginning in any state, it may have an end either in that state or in another. Accordingly, Plato asserts in plain terms its eternity and self-existence, which, as we learn from Cicero, he infers from its being the principle of motion in man. “Quin etiam cæteris, quæ moventur, hic fons, hoc principium est movendi. *Principii autem nulla est origo.* Nam ex principio oriuntur omnia: ipsum autem nulla ex re alia nasci potest: nec enim esset id principium, quod gigneretur aliunde §.” This, it must be acknowledged, is very contemptible reasoning; but the opinion which it was intended to prove was held by all the philosophers. They were unanimous in maintaining the *substance* of the soul, though not its *personality*, to be eternal *à parte ante* as well as *ad partem post*; and Cicero, where he tells us that this opinion passed from *Phercydes*, *Syrus*, to *Pythagoras*, and from *Pythagoras* to *Plato*, expresses their notion of the soul's duration by the word *sempiternus* *, which, in its original and proper sense, is applicable only to that which has neither beginning nor end.

Indeed none of the philosophers of ancient Greece appear to have believed a creation (see CREATION) possible: for it was a maxim universally received among them, *De nihilo nihil fit, in nihilum nil posse reverti*; that nothing can come from nonentity, or go to nonentity. This maxim, as held by the theistical philosophers, the learned Cudworth labours to interpret in a sense agreeable

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† See the
Procedure,
Extent, and
Limits of the
Understanding.

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The philo-
sophers of
ancient
Greece be-
lieved like-
wise in
pre-exist-
ence,

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And abse-
lute eter-
nity.

§ *Tuscul.*
lib. i. cap. 23

* *Tuscul.*
lib. i.

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able to our notions of the origin of the world; but the quotations urged by himself must convince every competent reader that on this occasion he labours in vain. For instance, when Aristotle writes of Parmenides and Melissus, that οὐδὲν οὐδὲ γίνεσθαι φασιν οὐδὲ φθίρεισθαι τῶν ὄντων, they say that no real entity is either made or destroyed; what can be his meaning, but that those philosophers taught that nothing could be either created or annihilated? He testifies the same thing of Xenophanes and Xenon, when he says that it was a fundamental principle of their philosophy—μη ἐνδεχίσθαι γίνεσθαι μὲν ἐκ μὲνενος—that it is impossible that any thing should be made out of nothing. And of Empedocles, when he relates ἀπάντα ταῦτα κακείνος ὁμολογεῖ ὅτι ἐκ τε μὴ ὄντος ἀμνηχανον ἐστὶ γίνεσθαι το τε οὐ ἐξολυσθαι ἀννυσον καὶ ἀρρηκλον—that he acknowledges the very same thing with other philosophers, viz. that it is impossible that any thing should be made out of nothing, or perish into nothing. But it is needless to multiply quotations respecting the opinions of single philosophers. Of all the physiologers before himself and Plato, Aristotle says, without exception, περὶ ταύτης ὁμογνομονουσι τῆς δόξης διὰ περὶ φύσεως, ὅτι το γιγνομενον ἐκ μὴ ὄντων γίνεσθαι ἀδυνατον†—That they agree in this opinion, that it is impossible that any thing should be made out of nothing; and he calls this the common principle of naturalists; plainly intimating, that they considered it as the greatest absurdity to suppose that any real entity in nature could either be brought from nothing or reduced to nothing.

† Physic.
lib. i. cap. 5.

The author of the *Intellectual System*, in order, perhaps, to hide the impiety of this principle, endeavours to persuade his readers, that it was urged only against the hypothesis of forms and qualities of bodies considered as real entities, distinct from matter. But how it could be supposed to militate against that particular opinion, and not against the possibility of all creation, is to us perfectly inconceivable. The father of the school which analysed body into matter and form, together with by far the greater part of his followers, taught the eternity of both these principles (1); and therefore maintained, as strenuously as any atomist, the universal maxim, *De nihilo nihil fit*. Even Plato himself, whose doctrine of *ideas* is supposed to wear a more favourable aspect than Aristotle's *forms* to the truths of revealed religion, taught the eternity of matter; but whether as a self-existing substance, or only as an emanation from the Deity, is a question which has been disputed. That he admitted no proper creation, may be confidently inferred from Plutarch; who writing upon the generation of animals, according to the doctrine laid down in the *Timæus*, has the following passage: Βελτιον ουν, Πλάτωνι πειθομενους τον μεν

κοσμον υπο θεου γεγονεναι λεγειν και αβειν* ο μεν γαρ καλλιστος των γε- Of the Im-
γονων οδε αριστος των αιτιων την δε ΟΤΣΙΑΝ και Τ' ΔΗΝ εξ ης γιγο mortality of
νεν ου γενομενην, αλλα υποκειμενην αει τω δημιουργω εις διαθεσιν the Soul.
και ταξιν αυτης, και προς εξομοιωσιν, ως δυνατον ην παρσσαι χειν ου γαρ
εκ του μη ὄντος ἡ γενεσις, αλλ' ἐκ του μη καλως, μηδ' ἱκανως εχοντος,
ὡς οικιας και ἱματιου, και ανδριανος †. It is therefore better for † Plut. Opus-
us to follow Plato, and to say and sing that the world was tom. ii.
made by God. For as the world is the best of all works, so P. 1014.
is God the best of all causes. Nevertheless, the SUBSTANCE
or MATTER out of which the world was made, was NOT
itself made, but was always ready at hand, and subject to
the artificer, to be ordered and disposed by him. For the
making of the world was not the production of it out of no-
thing, but out of an antecedent bad and disorderly state, like
the making of a house, garment, or statue.

If, then, this be a fair representation of the sentiments of Plato, and surely the author understood those sentiments better than the most accomplished modern scholar can pretend to do, nothing is more evident, than that the founder of the academy admitted of no proper creation, but only taught that the matter which had existed from eternity in a chaotic state, was in time reduced to order by the *Demiurgus*, or supreme Being. And if such were the sentiments of the divine Plato, we cannot hesitate to adopt the opinion of the excellent Mosheim, which the reader will probably be pleased to have in his own words. “Si a Judæis discedas, nescio an ullus antiquorum philosophorum mundum negaverit æternum esse. Omnes mihi æternum professi videntur esse mundum: hoc uno vero disjunguntur, quod nonnulli, ut *Aristoteles*, formam et materiam simul hujus orbis, alii vero, quorum princeps facile Plato, materiam tantum æternam, formam vero, a Deo comparatam, dixerunt †.”

Now it is a fact so generally known, as not to stand in need of being proved by quotations, that there was not among them a single man who believed in the existence of mind as a being more excellent than matter, and essentially different from it, who did not hold the superior of at least equal antiquity with the inferior substance. So true is this, that Synesius, though a Christian, yet having been educated in one of the schools of philosophy, could not by the hopes of a bishopric be induced to dissemble this sentiment: αμελει την ψυχην ουκ αξιωσω ποτε σωματιος υστερογενη νομιζειν*.—* Epist. 105.
I shall never be persuaded to think my soul younger than my body. This man probably believed upon the authority of the scriptures, that the matter of the visible world was created in time; but he certainly held with his philosophic masters, that his own soul was as old as any atom of it, and that it had consequently existed in a prior state before it animated his present body,

† Notes on
Cudworth's
Intellectual
System.

Those

(1) *Aristotelem*, et plerisque Peripateticorum, in vulgus notum est, in hac fuisse sententia—nec natum esse, nec interitum unquam hunc mundum. Vid. *Petrus Gassendus Physic.* sect. i. lib. i. cap. 6. *Jac. Thomasius de Stoica mundi exustione*, Diff. 4. et alii. Plures ita haud dubie senserunt philosophorum veterum. Hinc video *MANILIUM* in *Astronomico Lib. i.* inter philosophorum de mundo sententias hanc, ac si præcipua esset, primo commemorare loco:

Quem sive ex nullis repentem semina rebus,
NATALI QUOQUE EGERE placet, semperque FUISSE,
ET FORE, PRINCIPIO pariter FATIQUE carentem.

Mosheim's edition of Cudworth's *Intellectual System*, lib. i. cap. 3. sect. 33. note 60. On this subject see also *Ancient Metaphysics*.

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mortality of
the Soul.

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They sup-
posed all
souls to be
emanations
from the
first mind;

* De Gene-
ratione Ani-
malium,
lib. ii. cap. 3.
† Eclog.
Phyf. c. 20.

‡ Epist. 92.

* De Placi-
tis Philoso-
phorum,
lib. iv. cap. 7.

* Plato
Quest.

§ De Divi-
natione, lib. i.
cap. 49.

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But differ-
ed in opi-
nion as to
the mode of
their sepa-
ration.

Those who maintained that the world was uncreated, maintained upon the same principle that their souls were uncreated likewise; and as they conceived all bodies to be formed of one first matter, so they conceived all souls to be either emanations from the one first Mind, or discerpted parts of it. Aristotle, who distinguishes between the intellectual and sensitive souls, says expressly of the former, that "it enters from without, and is DIVINE;" adding this reason for his opinion, that "its energy is not blended with that of the body—*λείπει δὲ τοῦ νοῦν μόνον θύρα· ἐν ἐπει-*

σινεῖν, καὶ θεῖον εἶναι μόνον· οὐδὲ γὰρ αὐτοῦ τῇ ἐνεργείᾳ κοινωνοῦναι σώματι· * As to the Stoics, *Cleanthes* held (as *Sto- bæus* informs us †), that "every thing was made out of one, and would be again resolved into one." But let *Seneca* speak for them all: "Quid est autem, cur non existimes in eo divini aliquid existere, qui DEI PARS est? Totum hoc, quo continemur, et unum est, et Deus: et focii ejus sumus, et membra||—*Why should you not believe something to be divine in him, who is indeed PART OF GOD? That WHOLE in which we are contained is ONE, and that one is GOD; we being his companions and MEMBERS.* *Epicetus* says, *The souls of men have the nearest relation to God, as being PARTS or FRAGMENTS of him, DISCERPTED and TORN from his SUBSTANCE: συναρτίς τῷ θεῷ, αἱ αὐτοῦ μοῖρα οὐσαι καὶ ἀποσπασματα.* Plato writes to the very same purpose, when, without any softening, he frequently calls the soul *God*, and *part of God*. And *Plutarch* says, that "Pythagoras and Plato held the soul to be immortal; for that, launching out into the soul of the universe, it returns to its parent and original—*Πυθαγόρας, Πλάτων, ἀφθάρτου εἶναι τὴν ψυχὴν· ἐξίουσαν γὰρ εἰς τὴν τοῦ παντός ψυχὴν, ἀναχωρεῖν πρὸς τὸ ὁμο- μένους* †. *Plutarch* declares his own opinion to be, that "the soul is not so much the work and production of God, as a PART of him; nor is it made BY him, but FROM him, and OUT of him: ἡ δὲ ψυχὴ οὐκ ἐργον ἐστὶ μόνον, ἀλλὰ καὶ μέρος· οὐδ' ἂν αὐτοῦ, ἀλλ' ἈΠ' αὐτοῦ, καὶ ἘΞ αὐτοῦ γέγονεν *." But it is needless to multiply quotations.

Cicero delivers the common sentiments of his Greek masters on this head, when he says §, "A natura deorum, ut doctissimis sapientissimisque placuit, HAUSTOS animos et LIBATOS habemus." And again: "Humanus autem animus DECERPTUS EX MENTE DIVINA: cum alio nullo, nisi cum ipso Deo (si hoc fas est dictu), comparari potest." While the philosophers were thus unanimous in maintaining the soul to be a part of the self-existent Substance, they differed in opinion, or at least expressed themselves differently, as to the mode of its separation from its divine parent.

Cicero and the Stoics talk as if the Supreme Mind were extended, and as if the human soul were a part literally torn from that mind, as a limb can be torn from the body. The Pythagoreans and Platonists seem to have considered all souls as emanations from the divine Substance rather than as parts torn from it, much in the same way as rays of light are emanations from the sun. Plato, in particular, believed in two self-existent principles, God and matter. The former he considered as the supreme Intelligence, incorporeal, without beginning, end, or change; and distinguished it by the appellation of *τὸ ἀγαθόν*, the Good. Matter, as subsisting from eternity, he considered as without any one form or quality whatever, and as having a natural tendency to disorder. Of this chaotic mass God formed a perfect world, after the eternal pattern in his own mind, and endowed it with a soul or emanation from himself. In the language of Plato, therefore, the universe being animated by a soul which proceeds from God, is called the *son of God*; and several parts of nature, particularly the heavenly bodies, are *gods*. The human soul, according to him, is derived by emanation from God, through the intervention of this soul of the world; and receding farther from the first intelligence, it is inferior in perfection to the soul of the world, though even that soul is debased by some material admixture. To account more fully for the origin and present state of human souls, Plato supposes *, that "when God formed the uni-

verse, he separated from the soul of the world inferior souls, equal in number to the stars, and assigned to each its proper celestial abode; but that those souls, (by what means, or for what reason, does not appear), were sent down to the earth into human bodies, as into sepulchres or prisons." He ascribes to this cause the depravity and misery to which human nature is liable; and maintains, that it "is only by disengaging itself from all animal passions, and rising above sensible objects, to the contemplation of the world of intelligence, that the soul of man can be prepared to return to its original state." Not inconsistently with this doctrine, our philosopher frequently speaks of the soul of man as consisting of three parts: or rather he seems to have thought that man has three souls; the first the principle of intelligence, the second of passion, and the third of appetite (M); and to each he assigns its proper place in the human body. But it was only the intellectual soul that he considered as immortal.

Aristotle

(M) "Plato triplicem finxit animam; cujus principatum, id est, rationem, in capite, sicut in arce, posuit: et duas partes separare voluit, iram et cupiditatem, quas locis discluit; iram in pectore, cupiditatem subter precordia locavit." *Ciceronis Tusc. Quest. lib. i. cap. 10.*

This hypothesis has been adopted by the learned author of *Ancient Metaphysics*: but it cannot be proved by argument, and is in direct opposition to consciousness. Were there three distinct minds in each man—the principles of intelligence, of passion, and of appetite, it is obvious that *each man* would be *three persons*, and that *none* of these persons could know any thing of the powers and properties of the *other two*. The intelligent person could not reason about *passion* or *appetite*; nor could the persons who know nothing but passion and appetite reason about *intelligence*, or indeed about any thing else. The very question at issue, therefore, furnishes the most complete proof possible, that the same individual which each man calls himself, is the principle of intelligence, of passion, and of appetite, for if the Platonic hypothesis were true, that question could never have been started, as no one individual of the human race could have understood all its terms. It may be just worth while to mention, that the author of *Ancient Metaphysics*, attributing all motion,

Of the Im-
mortality of
the Soul.

* *Enfield's*
Abridgement
of Brucker's
History of
Philosophy.

Of the Im-
mortality of
the Soul.

Of the Im-
mortality of
the Soul.

† *Academi-
cium*, lib. i.
cap. 6.

* *De Gene-
ratione Ani-
malium*,
lib. iii. c. ii.

† *Tuscul.*
lib. i. c. 3.

* *De Gene-
ratione Ani-
malium*,
lib. ii. c. 3.

Aristotle taught, in terms equally express, that the human soul is a part of God, and of course that its substance is of eternal and necessary existence. Some of his followers, indeed, although they acknowledged *two first principles*, the active and the passive, yet held, with the Stoics, but *one substance* in the universe; and to reconcile these two contradictory propositions, they were obliged to suppose matter to be both active and passive. Their doctrine on this subject is thus delivered by Cicero: "De natura ita dicebant, ut eam dividerent in res duas, ut altera esset efficiens, altera autem quasi huic se præbens, ea quæ efficeretur aliquid. In eo, quod efficeret, vim esse censebant; in eo autem quod efficeretur, materiam quandam; in utroque tamen utrumque. Neque enim materiam ipsam coherere potuisse, si nulla vi contineretur, neque vim sine aliqua materia; nihilest enim, quod non alicubi esse cogatur†." They divided nature into two things, as the first principles; one whereof is the efficient or artificer, the other that which offers itself to him for things to be made out of it. In the efficient principle, they acknowledged active force; in the passive, a certain matter; but so, that in each both of these were together: forasmuch as neither the matter could cohere together unless it were contained by some active force, nor the active force subsist of itself without matter; because that is nothing which may not be compelled to be somewhere. Agreeably to this strange doctrine, Arrian, the interpreter of Epictetus, says of himself, *ἡμεῖς ἀνθρώποις, μέρος τῶν πάντων, ὡς ὅρα ἡμεῖς*, "I am a man (a part of the *τὸ πᾶν* or universe), as an hour is part of the day.

Aristotle himself is generally supposed to have believed in the eternal existence of two substances, *mind* and *matter*; but treating of the generation of animals, he says, *ἔνδε το πᾶντι θερμότης ψυχικὴ, ὡς τροπὴν τινὰ πᾶντα ψυχῆς ἵναί πληρὴ διασυνιστάται ταχέως ὅποσον ἐμπεριλάβῃ **, In the universe there is a certain animal heat, so as that after a manner all things are full of mind; wherefore they are quickly completed (or made complete animals) when they have received a portion of that heat. This heat, from which, according to Cicero†, the Stagyrice derived all souls, has, it must be confessed, a very material appearance; inasmuch that the learned Mosheim seems to have been doubtful whether he admitted of any immaterial principle in man; but for this doubt there appears to us to be no solid foundation. Aristotle expressly declares, that *this heat is not fire nor any such power, but a spirit which is in the seeds or elementary principles of bodies*; *τοῦτο δὲ οὐ πῦρ, οὐδὲ τοιαύτη δύναμις ἐστίν, ἀλλὰ τὸ ἐμπεριλαμβανόμενον ἐν τῷ σπέρματι καὶ ἐν τῷ ἀρρῶδι πνεῦμα **.

And as the excellent person himself acknowledges (N),

that Aristotle taught the existence of two principles, God and matter, not indeed subsisting separately, but eternally linked together by the closest union; we think it follows undeniably, that this heat, from which he derived all souls, must be that mind which he called God, and which he considered as the actuating soul of the universe.

Upon these principles neither Aristotle nor the Stoics could believe with Plato, that in the order of nature there was first an emanation from the supreme mind to animate the universe, and then through this universal soul other emanations to animate mankind. The Stagyrice believed, that the Supreme Mind himself is the soul of the world, and that human souls are immediately derived from him. The genuine Stoics, acknowledging but one substance, of necessity considered both the souls and bodies of men as portions of that substance, which they called *τὸ ἐν*; though still they affected to make some unintelligible distinction between body and mind. But however the various schools differed as to those points, they were unanimous as to the soul's being a part of the self-existing Substance; and Cicero gives their whole system from Paccuvianus in words which cannot be misunderstood:

Quicquid est hoc, omnia animat, format, alit, auget, creat, Sepelit, recipitque in sese omnia, omniumque idem est Pater: Indidemque eadem, quæ oriuntur de integro, atque eodem occidunt.

To these verses he immediately subjoins the following query: "Quid est igitur, cur, cum domus sit omnium una, eaque communis, cumque animi hominum semper fuerint, futuri que sint, cur ii, quid ex quoque eveniat, et quid quamque rem significet, perspicere non possint?" And upon the same principle he elsewhere argues, not merely for the immortality, but for the eternity and necessary existence of the soul: "Animorum nulla in terris origo invenire potest: His enim in naturis nihil inest, quod vim memoriæ mentis, cogitationis habeat; quod et præterita teneat, et futura provideat, et complecti possit præsentia; quæ sola divina sunt. Nec inveniuntur unquam, unde ad hominem venire possint, nisi a Deo. Ita quicquid est illud, quod sentit, quod sapit, quod vult, quod viget, cælestis et divinum est; ob eamque rem æternum sit necesse est." This was indeed securing the future permanency of the soul in the most effectual manner; for it is obvious, that what had not a beginning can never have an end, but must be of eternal and necessary existence.

But when the ancients attribute a proper eternity to the soul, we must not suppose that they understood it to be eternal in its distinct and personal existence. They believed that it proceeded or was described in time from the

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Upon these principles they maintained the necessary existence of the soul; || *De Divisione*, lib. i. cap. 57.

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But not in its distinct and personal capacity.

tion, and even the coherence of the minute particles of body, to the immediate agency of mind, of course furnishes every human body with at least four minds. This fourth mind differs not from the plastic nature of Cudworth, and is likewise a Platonic notion apparently better founded. That there are in our bodies motions perpetually carried on by the agency of something which is not the principle of either our intelligence, our passions, or our appetites, is a fact which cannot be denied; but if those motions proceed immediately from mind, it must be either from the supreme mind, or from some subordinate mind, acting under the supreme, but wholly distinct from and independent of that which each man calls himself.

(N) "Non cum illis componi prorsus potest Aristoteles, qui bina rerum separataque statuunt principia, Deum et materiam. Artissime enim utrumque hoc initium conjunxit Stagyrice, atque ipsa naturæ necessitate Deum coherere cum mole hac corporea putavit." Cudworth's Intellectual System, Book I. Chap iv. Sect. 6. Note 3.

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the substance of God, and would *in time* be again *re-
solved* into that substance. This they explained by a
closed vessel filled with sea-water; which swimming a
while upon the ocean, does, on the vessel's breaking,
flow in again, and mingle with the common mass.
They only differed about the time of this reunion;
the greater part holding it to be at death; but the
Pythagoreans not till after many transmigrations. The
Platonists went between these two opinions; and re-
joined pure and unpolluted souls immediately to the
Universal Spirit; but those which had contracted much
defilement, were sent into a succession of other bodies,
to be purged and purified, before they returned to
their parent substance.†

† Warbur-
ton's Divine
Legation.

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A similar
doctrine
held by the
Bramins.

A doctrine similar to this of Plato has been held
from time immemorial by the Bramins in India, whose
sacred books teach, "That intellect is a PORTION of
the GREAT SOUL of the universe, breathed into all
creatures, to animate them for a certain time; that af-
ter death it animates other bodies, or returns like a
drop into that *unbounded ocean* from which it first arose;
that the souls of men are distinguished from those of
other animals, by being endowed with reason and
with a consciousness of right and wrong; and that the
soul of him who adheres to right as far as his powers
extend, is at death ABSORBED INTO THAT DIVINE ES-
SENCE, never more to reanimate flesh. On the other
hand, the souls of those who do evil, are not at death
disengaged from all the elements; but are immedi-
ately clothed with a body of fire, air, and *akash* (a kind
of celestial element, through which the planets move,
and which makes no resistance) in which they are for a
time punished in hell. After the season of their grief
is over, they reanimate other bodies; and when they
arrive through these transmigrations at a state of pu-
rity, they are absorbed into God, where all PASSIONS
are UTTERLY UNKNOWN, and where CONSCIOUSNESS
IS LOST IN BLISS‡."

‡ See Preli-
minary Dis-
sertation to
Now's Hi-
story of In-
doian.

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This doc-
trine in-
compatible
with a fu-
ture state of
rewards
and punish-
ments, and

Whether the Greeks derived their notions of the
divinity and transmigration of souls from the east, or
whether both they and the Bramins brought the same
doctrines at different periods from Egypt, it is foreign
from the purpose of this article to inquire. Certain it
is, that the philosopher's of Greece and India argued
in the very same manner, and upon the very same prin-
ciples, for the *natural* immortality of the soul; and
that the immortality which they taught was wholly
incompatible with God's moral government of the
world, and with a future state of rewards and punish-
ments. That this is true of the doctrine of the Bra-
mins, is evident from the last quoted sentence: for if
the soul, when absorbed into the Divine essence, loses
all consciousness of what it did and suffered in the
body, it cannot possibly be rewarded for its virtues
practised upon earth. That the philosophers of Greece
taught the same cessation of consciousness, might be
inferred with the utmost certainty, even though we
had not Aristotle's express declaration to that purpose:

Nº 215.

For as they all believed their souls to have existed be-
fore they were infused into their bodies, and as each
must have been conscious that he remembered nothing
of his former state (o), it was impossible to avoid con-
cluding, that in the future state of his soul as little would
be remembered of the present. Accordingly Aristotle
teaches, that "the agent intellect only is immortal and
eternal, but the passive corruptible", — *τοῦτο μόνον ἀθάνατον
καὶ αἰδιον ὁ δὲ παθητικὸς νοῦς φθαρτός* *. Cudworth thinks this
a very doubtful and obscure passage; but Warburton,
whose natural acuteness often discovered the sense of
ancient authors when it had escaped the sagacity of
abler scholars, has completely proved, that by the *agent
intellect* is meant the *substance* of the soul, and by the
passive its *particular perceptions*. It appears therefore
that the Stagyrte, from the common principle of the
soul's being a part of the Divine substance, draws a con-
clusion against a future state of rewards and punishments;
which though all the philosophers (except Socrates)
embraced, yet all were not so forward to avow.

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mortality of
the Soul.

That the hypothesis of the soul's being a part of
the Divine substance is a gross absurdity, we surely
need not spend time in proving. The argument long
ago urged against it by St Austin must ere now have
occurred to every reader. In the days of that learned
father of the church, it was not wholly given up by
the philosophers; and in his excellent work of the
City of God, he thus exposes its *extravagance* and im-
piety: "Quid infelicius credi potest, quam Dei par-
tem vapulare, cum puer vapulat? Jam vero partes Dei
fieri lascivas, iniquas, impias, atque omnino damnabiles,
quis ferre potest nisi qui prorsus insanit?"

But though this hypothesis be in the highest degree
absurd and wholly untenable, we apprehend it to be the
only principle from which the *natural* or *essential* immor-
tality of the soul can possibly be inferred. If the soul had
a *beginning*, it *may* have an *end*; for nothing can be more
evident than that the being which had not existence of
itself cannot of itself have perpetuity of existence. Hu-
man works, indeed, continue in being after the power
of the workman is withdrawn from them; but between
human works and the Divine there is this immense dif-
ference, that the former receive from the artist nothing
but their form; whereas the latter receive from the
Creator both their form and their substance. Forms
are nothing but modifications of substance; and as
substances depend upon God and not upon man, hu-
man works are continued in being by that fiat of the
Creator, which made the substances of which they are
composed susceptible of different forms, and of such a
nature as to retain for a time whatever form may be
impressed upon them. Human works therefore are
continued in being by a power different from that by
which they are finished; but the works of God de-
pend wholly upon that power by which they were ori-
ginally brought into existence; and were the Creator
to withdraw his supporting energy, the whole creation
would sink into nothing.

8

Self-

(o) This is expressly acknowledged by Cicero, though he held with his Greek masters the eternity of the
soul. In answer to some very foolish assertions concerning the evil of death, he says, "Ita, qui nondum
nati sunt, miseri jam sunt, quia non sunt: et nos ipsi, si post mortem miseri futuri sumus, miseri fui-
mus antequam nati. Ego autem non commemini, antequam sum natus, me miserum. *Tuscul. lib. 1. cap. 6.*

Immorta-
lity of the
Soul.

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Baxter's ar-
gument for
the natural
or essential
immortali-
ty of the
soul

* Inquiry
into the Na-
ture of the
human Soul,
vol. i.
sect. 3.

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Inconclu-
sive,

Self-evident as this truth certainly is, some eminent philosophers *seem* to have questioned it. "No substance or being (says Mr Baxter *) can have a natural tendency to annihilation, or to become nothing. That a being which once exists should cease to exist is a real effect, and must be produced by a real cause: But this cause could not be planted in the nature of any substance or being to become a tendency of its nature; for it could not be a free cause, otherwise it must be a being itself, the subject of the attribute freedom, and therefore not the property of another being; nor a necessary cause, for such a cause is only the effect of something imposing that necessity, and so no cause at all."

That the author's meaning in this argument is good, cannot, we think, be controverted; but he has not expressed himself with his usual accuracy. He seems to confound causes with the absence of causes, and the effects of the former with the consequences of the latter. The visible world was brought into existence by the actual energy of the power of God; and as the visible world had nothing of itself, it can remain in existence only by a continuance of the same energy. This energy therefore is at the present moment as real a cause as it was six thousand years ago, or at any past period when it may have been first exerted; and the visible world is its real and permanent effect. But would the ceasing of this energy be likewise a cause? It would certainly be followed with the annihilation of the visible world, just as the withdrawing of the sun-beams would be followed with darkness on the earth. Yet as no one has ever supposed that darkness, a non-entity, is a positive effect of the sun or of his beams, but only a mere negative consequence of their absence; so, we think, no one who believes in creation can consider that destruction which would inevitably follow the withdrawing of the energy by which all things are supplied, as the positive effect of a contrary energy, or as any thing more than a negative consequence of the ceasing of that volition or energy of power by which God at first brought things into existence. For "where the foundation of existence lies wholly in the power of an infinite Being producing, the ground of the continuance of that existence must be wholly in the same power conserving; which has, therefore, with as much truth as frequency, been styled a continued creation (P)."

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and in ef-
fect given
up by him-
self.

The force of this reasoning Mr Baxter certainly saw when he said, that "a tendency to persevere in the same state of nature, and a tendency to change it, are contradictories, and impossible to be planted in the same subject at once: or, not to urge the contradiction, if the last prevailed, the remaining in the same state for any given time would be impossible. We forget the true cause of all these tendencies, the will of God, which it is absurd to suppose contrary to itself. The tendency in matter to persevere in the same state of

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rest or motion, is nothing but the will of the Creator, who preserves all things in their existence and manner of existence: nor can we have recourse to any other cause for the preservation of immaterial substance in its existence. Therefore these tendencies are to be ascribed to the will of God, and it is absurd to suppose them contrary."

All this is unquestionably true. The existence or non-existence of matter and of created spirits depends wholly upon the will of God; and we cannot suppose him to be willing to-day the reverse of what he willed yesterday, because we know that all his volitions are directed by unerring wisdom. We have likewise the evidence of experience, that nothing is ever suffered to perish but particular systems, which perish only as systems by a decomposition of their parts. A being, which like the soul has no parts, can suffer no decomposition; and therefore, if it perish, it must perish by annihilation. But of annihilation there has not hitherto been a single instance; nor can we look for a single instance without supposing the volitions of God to partake of that unsteadiness which is characteristic of man. Corporeal systems, when they have served their purpose, are indeed resolved into their component parts; but the matter of which they were composed, so far from being lost, becomes the matter of other systems in endless succession. Analogy, therefore, leads us to conclude, that when the human body is dissolved, the immaterial principle by which it was animated continues to think and act, either in a state of separation from all body, or in some material vehicle to which it is intimately united, and which goes off with it at death; or else that it is preserved by the Father of spirits, for the purpose of animating a body in some future state. When we consider the different states through which that living and thinking individual, which each man calls himself, goes, from the moment that it first animates an embryo in the womb, to the dissolution of the man of fourscore; and when we reflect likewise on the wisdom and immutability of God, together with the various dissolutions of corporeal systems, in which we know that a single atom of matter has never been lost; the presumption is certainly strong, that the soul shall subsist after the dissolution of the body. But when we take into the consideration the moral attributes of God—his justice and goodness, together with the unequal distribution of happiness and misery in the present world; this presumption from analogy amounts to a complete moral proof that there shall be a future state of rewards and punishments (Q). (See MORAL Philosophy and RELIGION); and if we estimate the duration of the rewards by the benevolence of Him by whom they are to be conferred, we cannot imagine them shorter than eternity.

4 F

CHAP.

(P) See Stillingfleet's *Origines Sacrae*, where this question is treated in a very masterly manner by one of the ablest metaphysicians of the last century. See also our article PROVIDENCE.

(Q) It was by such arguments that Socrates reasoned himself into the belief of a future state of rewards and punishments. He was singular, as we have already observed, in this belief; and he was as singular in confining himself to the study of morality. "What could be the cause of this belief, but this restraint, of which his belief was a natural consequence? For having confined himself to morals, he had nothing to mislead him; whereas the rest of the philosophers, applying themselves with a kind of fanaticism to physics and metaphysics, had drawn a number of absurd, though subtle, conclusions, which directly opposed the consequences of those moral arguments." Warburton's *Div. Leg.* vol. ii.

Of Ne-
cessity and
Liberty.

CHAP. V. Of NECESSITY and LIBERTY.

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Freedom of
agency im-
plied in ac-
countable-
ness.

IN the preceding chapter we have adverted to that great *moral proof* for a future state, and the immortality of the soul, arising from the relation in which man, as a being accountable for his conduct, stands to a God of almighty power, infinite wisdom, and perfect justice. But the circumstance of accountability implies freedom of agency; for it is contrary to all our notions of right and wrong (see *MORAL Philosophy*), that a man should be either rewarded or punished for actions which he was necessitated or compelled to perform.

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Every man
has power
to do what
he wills:

Human actions are of three kinds: one, where we act by instinct, without any view to consequences; one, where we act by will, in order to obtain some end; and one, where we act against will. It is the second kind of actions only which confers upon the agent merit or demerit. With respect to the first, he acts blindly (see *INSTINCT*), without deliberation or choice; and the external act follows from the instinctive impulse, no less necessarily than a stone by its gravity falls to the ground. With respect to the last, he is rather an instrument than an agent; and it is universally allowed, that were a strong man to put a sword into the hand of one who is weaker, and then to force it through the body of a third person, he who held the sword would be as guiltless of the murder as the sword itself. To be intitled to rewards, or liable to punishment, a man must act voluntarily; or in other words, his actions must proceed from that energy of mind which is termed *volition*: and, we believe, it has never been denied, that all men have power to do whatsoever they *will*, both with respect to the operations of their minds and the motions of their bodies, uncontrolled by any foreign principle or cause. "Every man (says Priestley) is at liberty to turn his thoughts to whatever subject he pleases, to consider the reasons for or against any scheme or proposition, and to reflect upon them as long as he shall think proper; as well as to walk wherever he pleases, and to do whatever his hands and other limbs are capable of doing." Without such liberty as this, morality is inconceivable.

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But differ-
ent opi-
nions enter-
tained of
the free-
dom of vo-
lition.

But though philosophers have in general agreed with respect to the power which a man has to perform such actions as he wills, they have differed widely in opinion respecting the nature of his volitions. That these are the result of motives, has seldom if ever been questioned; but whether that result be necessary, so as that the agent has no self-determining power to decide between different motives, has been warmly disputed by men equally candid, impartial, and intelligent. The principal writers on the side of necessity are, Hobbes, Collins, Hume, Leibnitz, Lord Kames, Hartley, Edwards, Priestley, and perhaps Locke. On the other side are, Clarke, King, Law, Reid, Butler, Price, Bryant, Wollaston, Horsley, Beattie, and Gregory, &c. To give a short view of this celebrated question, is all that our limits will permit; and as we do not think ourselves competent to settle the dispute, it were perhaps a thing desirable to give the opposite reasonings in the words of those eminent authors themselves. It must, however, be obvious to the reader, that the style and manner of so many different

writers are extremely various, and that to introduce them all into our abstract, would make the whole a mass of confusion. We shall, therefore, select one writer to plead the cause of necessity, supplying his defects from those who, though inferior to him on the whole, may yet have argued more ably on some particular points which the question involves: and to this combined reasoning we shall subjoin such answers as to us appear most conclusive. Hartley, Hume, and Priestley, are perhaps the most profound reasoners on the side of necessity; but there is so much more perspicuity in the arguments of Lord Kames, that we cannot help preferring them, as being on the whole better calculated to give the ordinary reader a fair view of the subject.

"Into actions done with a view to an end (says his Lordship §), desire and will enter: desire to accomplish the end goes first; the will to act, in order to accomplish the end, is next; and the external act follows of course. It is the will then, that governs every external act done as a mean to accomplish an end; and it is desire to accomplish the end that puts the will in motion; desire, in this view, being commonly termed the *motive* to act. But what is it that raises desire? The answer is ready: It is the prospect of attaining some agreeable end, or of evading one that is disagreeable. And if it be inquired, what makes an object agreeable or disagreeable? the answer is equally ready: It is our nature that makes it so. Certain visible objects are agreeable, certain sounds, and certain smells: other objects of these senses are disagreeable. But there we must stop; for we are far from being so intimately acquainted with our own nature as to assign the causes.

"With respect to instinctive actions, no person, I presume, thinks that there is any freedom. With respect to voluntary actions, done in order to produce some effect, the necessity is the same, though less apparent at first view. The external action is determined by the will; the will is determined by desire; and desire by what is agreeable or disagreeable. Here is a chain of causes and effects, not one link of which is arbitrary, or under command of the agent: he cannot will but according to his desire; he cannot desire, but according to what is agreeable or disagreeable in the objects perceived: nor do these qualities depend on his inclination or fancy; he has no power to make a beautiful woman ugly, nor to make a rotten carcase smell sweetly.

"Many good men, apprehending danger to morality from holding our actions to be necessary, endeavour to break the chain of causes and effects above mentioned; maintaining, that whatever influence desire or motives may have, it is the agent himself who is the cause of every action; that desire may advise, but cannot command; and, therefore, that a man is still free to act in contradiction to desire and to the strongest motives.

"That a being may exist which in every case acts blindly and arbitrarily, without having any end in view, I can make a shift to conceive: but it is difficult for me even to imagine a thinking and rational being, that has affections and passions, that has a desirable end in view, that can easily accomplish this end; and yet after all can fly off or remain at rest, without any cause, reason, or motive, to sway it. If such a

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cessity and
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Scheme of
necessity,
according
to Lord
Kames.
§ Sketches of
the History
of Man,
Book iii.
Sketch 2.
part 1.
sect. 8.

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whimsical being can possibly exist, I am certain that man is not that being. There is not perhaps a person above the condition of a changeling, but can say *why* he did so and so, what moved him, what he intended. Nor is a single fact stated to make us believe that ever a man acted against his own will or desire, who was not compelled by external force.—On the contrary, constant and universal experience proves, that human actions are governed by certain inflexible laws; and that a man cannot exert his self-motive power but in pursuance of some desire or motive.

“Had a motive always the same influence, actions proceeding from it would appear no less necessary than the actions of matter. The various degrees of influence that motives have on different men at the same time, and on the same man at different times, occasion a doubt, by suggesting a notion of chance. Some motives, however, have such influence as to leave no doubt: a timid female has a physical power to throw herself into the mouth of a lion roaring for food; but she is withheld by terror no less effectually than by cords: if she should rush upon a lion, would not every one conclude that she was frantic? A man, though in a deep sleep, retains a physical power to act, but he cannot exert it. A man, though desperately in love, retains a physical power to refuse the hand of his mistress; but he cannot exert that power in contradiction to his own ardent desire, more than if he were fast asleep. Now, if a strong motive have a necessary influence, there is no reason for doubting, but that a weak motive must also have its influence, the same in kind, though not in degree. Some actions indeed are strangely irregular; but let the wildest actions be scrutinised, there will always be discovered some motive or desire, which, however whimsical or capricious, was what influenced the person to act. Of two contending motives, is it not natural to expect that the stronger will prevail, however little its excess may be? If there be any doubt, it must arise from a supposition, that a weak motive may be resisted arbitrarily. Where then are we to fix the boundary between a weak and a strong motive? If a weak motive can be resisted, why not one a little stronger, and why not the strongest? Between two motives opposing each other, however nearly balanced, a man has not an arbitrary choice, but must yield to the stronger. The mind, indeed, fluctuates for some time, and finds itself in a measure loose: at last, however, it is determined by the more powerful motive, as a balance is by the greater weight after many vibrations.

“Such, then, are the laws that govern our voluntary actions. A man is absolutely free to act according to his own will; greater freedom than which is not conceivable. At the same time, as man is made accountable for his conduct to his Maker, to his fellow-creatures, and to himself, he is not left to act arbitrarily; for at that rate he would be altogether unaccountable: his will is regulated by desire; and desire by what pleases or displeases him.—Thus, with regard to human conduct, there is a chain of laws established by nature; no one link of which is left arbitrary. By that wise system, man is made accountable; by it he is made a fit subject for divine

and human government; by it persons of sagacity foresee the conduct of others; and by it the prescience of the Deity with respect to human actions is clearly established.”

Of the doctrine of necessity, a more perspicuous or plausible view than this is not to be found in any work with which we are acquainted. It is indeed defective perhaps, as his Lordship only *hints* at the nature of that relation which subsists between motive and action; but from his comparing the fluctuations of the mind between two contending motives, to the vibrations of a balance with different weights in the opposite scales, there is no room to doubt but that he agreed exactly in opinion with Mr Hume and Dr Priestley. Now both these writers hold, that the relation of motives to volition and action, is the very same with that which subsists between cause and effect in physics, as far as they are both known to us. “It is universally allowed (says Mr Hume†), that matter, in all its operations, is actuated by a necessary force; and that every natural effect is so precisely determined by the energy of its cause, that no other effect, in such particular circumstances, could possibly have resulted from it. The degree and direction of every motion is, by the laws of nature, prescribed with such exactness, that a living creature may as soon arise from the shock of two bodies, as motion in any other degree or direction than what is actually produced by it. Would we, therefore, form a just and precise idea of necessity, we must consider whence that idea arises, when we apply it to the operation of bodies. But our idea of this kind of necessity and causation arises entirely from the uniformity observable in the operations of nature, where similar objects are constantly conjoined together, and the mind is determined by custom to infer the one from the appearance of the other. These two circumstances form the whole of that necessity which we ascribe to matter. Beyond the *constant conjunction* of similar objects, and the consequent *inference* from one to the other, we have no notion of any necessity or connection.” He then gives a pretty long detail to prove a great uniformity among the actions of men in all nations and ages; and concludes that part of his argument with affirming, “not only that the conjunction between motives and voluntary actions is as regular and uniform as that between the cause and effect in any part of nature; but also, that this regular conjunction has been universally acknowledged among mankind, and has never been the subject of dispute either in philosophy or common life.” He afterwards observes, “that men begin at the wrong end of this question concerning liberty and necessity, when they enter upon it by examining the faculties of the soul, the influence of the understanding, and the operations of the will. Let them first discuss a more simple question, namely, the operations of body, and of brute unintelligent matter; and try whether they can there form any idea of causation and necessity, except that of a constant conjunction of objects and subsequent inference of the mind from one to another. If these circumstances form in reality the whole of that necessity which we conceive in matter, and if these circumstances be also universally acknowledged to take place in the operations of the mind, the dispute is at an end; at least

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Mr Hume,
and
† *Inquiry*
concerning
Human Un-
derstanding,
sect. 8.

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must be owned to be thenceforth merely verbal. When we consider how aptly *natural* and *moral* evidence link together, and form only one chain of argument, we shall make no scruple to allow that they are of the same nature, and derived from the same principles.—Between a connected chain of natural causes and voluntary actions, the mind feels no difference in passing from one link to another; nor is less certain of a future event which depends upon motives and volitions, than if it were connected with the objects present to the memory and senses by a train of causes, cemented together by what we are pleased to call a *physical* necessity. The same experienced union has the same effect on the mind, whether the united objects be motives, volition and action, or figure and motion. We may change the names of things, but their nature and their operation on the understanding never change.”

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Dr Priest-
ley.

* The Doc-
trine of phi-
losophical
Necessity il-
lustrated.

Dr Priestley, in words a little different, teaches the very same doctrine which was taught by Mr Hume.—“In every determination of the mind (says he *), or in cases where volition and choice are concerned, all the previous circumstances to be considered are the *state of mind* (including every thing belonging to the *will* itself), and the *views of things* presented to it; the latter of which is generally called the *motive*, though under this term some writers comprehend them both. To distinguish the *manner* in which events depending upon *will* and *choice* are produced, from those in which no volition is concerned, the former are said to be produced *voluntarily*, and the latter *mechanically*. But the same general maxims apply to them both. We may not be able to determine *a priori* how a man will act in any particular case; but it is because we are not particularly acquainted with his *disposition of mind*, *precise situation*, and *views of things*. But neither can we tell in which way the wind will blow to-morrow, though the *air* is certainly subject to no other than necessary laws of motion.

“It is universally acknowledged, that there can be no effect without an adequate cause. This is even the foundation on which the only proper argument for the being of a God rests. And the necessarian asserts, that if, in any given state of mind, with respect both to *disposition* and *motives*, two different determinations or volitions be possible, it can be so on no other principle, than that one of them shall come under the description of an *effect without a cause*; just as if the beam of a balance might incline either way, though loaded with equal weights. It is acknowledged, that the mechanism of the balance is of one kind, and that of the mind of another; and, therefore, it may be convenient to denominate them by different words; as, for instance, that of the balance may be termed a *physical*, and that of the mind a *moral* mechanism. But still, if there be a *real mechanism* in both cases, so that there can be only one result from the same previous circumstances, there will be a *real necessity*, enforcing an absolute certainty in the event. For it must be understood, that all that is ever meant by *necessity in a cause*, is that which produces *certainty in the effect*.”

Such is the nature of human volitions, according to every necessarian of eminence who has written on the subject since the days of Hobbes: and if this the-

ory be just, if there be a constant and inseparable conjunction of motives and actions similar to that of cause and effect in physics, it is obvious, that in volition the mind is as inert as body is in motion.

This consequence is indeed avowed and insisted upon by Hume, Priestley, and their adherents; whilst the advocates for human liberty, on the other hand, contend for an absolute exemption of the will from all internal *necessity*, arising from its own frame and constitution, the impulse of superior beings, or the operations of objects, reasons, or motives, &c. By this they do not mean, that between motives and volitions there is no relation whatever, or that a man can ever choose evil as evil, or refuse good as good. Such an assertion would be contrary to consciousness and universal experience. But what they endeavour to prove is, that the conjunction of motive and volition is not inseparable, like that of cause and effect in physics; that a man may in most cases choose according to any one of two or more motives presented to his view; that by choosing any thing, he may make it in some measure agreeable by his own act, or, to speak more properly, may bend his desire to it; that in volition, the mind is not inert; and that, therefore, we are under no *necessity* to act in a particular manner in any given case whatever.

That the conjunction of motive and action is not constant like that of cause and effect in physics, and that by consequence the mind in forming volitions is not inert, has been evinced by Dr Gregory with the force and precision of mathematical demonstration.—Former writers on the side of liberty had often observed, that upon the supposition of the *inertia* of mind, a man, with equal and opposite motives presented at once to his view, would, during their continuance, remain perfectly at rest, like a balance equally loaded in both scales. The observation is admitted to be just by all the advocates for necessity; but they contrive to evade its consequences, by denying that in any given case a man can be at once assailed by two equal and opposite motives. Thus, when it is said that a porter, standing with his face due north, must remain in that position at perfect rest, as long as equal motives shall at once be offered to him for travelling eastward and westward, the necessarians admit the force of the argument; but when it is added that a guinea, offered for every mile that he should travel in each of these opposite directions, ought therefore to fix him at rest till one of the offers be withdrawn, they deny that the desire of gaining the guineas is the *whole* of the motives which operate upon his mind. He may have, say they, some secret reason which we cannot discern for preferring the one direction to the other; and that reason, added to the guinea, will make him go eastward or westward, just as an ounce thrown into either scale of a balance poised by equal weights will make that scale preponderate. Though we think that this solution of the difficulty can satisfy no man who is not already biased to the necessarian system; and though, even were it to be admitted, it seems to militate against the constant conjunction of motives and actions, unless it can be proved that the porter must travel the road which he has been necessitated to choose with reluctance and a heavy heart; yet as it may admit of endless quibbling upon ambiguous words,

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the Relation
between Mo-
tive and Ac-
tion

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Demonstra-
tion that
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motive and
action is
constant.

words, the philosophical world is much indebted to Dr Gregory † for an argument which, in our opinion, can neither be overturned nor evaded, and which demonstrates that the conjunction of motive and action cannot be constant and inseparable, like that of cause and effect in physics.

His reasoning is to this purpose: Suppose a porter to be offered a guinea for every mile that he shall travel directly eastward. If there be no physical cause or moral motive to keep him at rest, or to induce him to move in another direction, there cannot be a doubt, upon either hypothesis, but he will gladly embrace the proposal, and travel in the direction pointed out to him, till he shall have gained as much money as to satisfy his most avaricious desires. The same thing would have happened, if a guinea had been offered for every mile that he should travel due south. In these two cases taken separately, the relation between the man's motives and his actions would be strikingly analogous to that between a single impulse and motion in physics. Let us now suppose the two offers to be made at the same instant, and the man to be assured that if he travel eastward he can have no part of the reward promised for his travelling to the south, and that if he travel southward he can have no part of the reward promised for his travelling to the east. What is he to do in this case? If his mind be inert in volition, and if the two motives operate upon him with the same necessity that causes operate in physics, it is obvious that the man could travel neither towards the east nor towards the south, but in a diagonal direction from north-west to south-east; and this he must do *willingly*, although perfectly satisfied that he could gain nothing by his journey. As this inference is contrary to fact and universal experience, the Doctor very justly concludes that the premises, from which it is deduced by mathematical reasoning, must be false and absurd; or, in other words, that the relation between motive and action cannot be that of constant conjunction, like the relation between cause and effect in physics.

He uses many arguments of the same kind, and equally convincing, to prove the absurdity of supposing the inertness of mind, and on'y an occasional conjunction of motives and actions; but we forbear to quote them, both because we wish his book to be read, and because we think the single argument which we have borrowed from him sufficient to demolish the theory of Priestley and Hume, which rests wholly upon the hypothesis of the *constant* conjunction of motive and action.

But is it then not really true, that the external action is determined by the will, the will by desire, and desire by what is agreeable or disagreeable? That the external action is universally determined by the will, is certainly true; but that the will is necessitated and universally determined by the desire is as certainly false. If Potiphar's wife was handsome, and made her proposal to Joseph with any degree of female address; and if his constitution was like that of other young men; there cannot be a doubt but that he felt a *desire* to do what she requested of him: yet we know that he *willed* to do otherwise, and in direct opposition to his *desire* fled from the room. Perhaps it may be said, that his volition to flee was the effect of a contrary and stronger

desire not to sin against God; but this is confounding the reader, by calling two energies of mind, between which there is little or no similarity, by the same name. He perceived, or knew, that to comply with his mistress's request would be to sin against God; he knew that he ought not to sin against God, and therefore he chose or determined himself not to do it. We can easily conceive how the presence, attitudes, and address, of the lady might be agreeable to him, and excite desire. There may very possibly be more than one of our readers, who, during the course of their lives, have experienced something of the same kind: but could abstract truth be in the same way agreeable, so as to excite in his mind a *desire* of virtue sufficient to annihilate or banish the *desire* of the woman? As well may it be said that one sensation can annihilate another, that the beautiful colours of the rainbow can remove the sensation of stench from the mind of him who is plunged into the midst of a dunghill, or that the smell of a rose can make a man insensible to the pain of a stroke inflicted by a bludgeon. Sensitive desire, and the perception of duty, are things so totally different, that to consider them as operating against each other, like different weights in the opposite scales of a balance, is as absurd as to suppose that sound can operate against colour, or colour against smell. A man may prefer sound to colour, or colour to smell, and act accordingly; but the determination must be wholly his own, unless these two sensations be themselves either agents or physical causes of the *same kind*, like the weights in the opposite scales of the balance.

The advocates for liberty do not pretend, that in matters of importance a man ever acts without some motive or reason for his conduct. All that they insist upon is, that between two or more motives of different kinds he has a liberty of choice, and that he does not always determine himself by that which he knows to be the greatest. Without such freedom, they think men might be often brought into situations where they could not act at all, and where inaction would at the same time be in the highest degree absurd. Thus, were two bags of gold, containing each a thousand or ten thousand guineas, to be placed on the same table, before a man whose family is perishing for want, and were the man to be told that he might take either of them, but not both, is it conceivable that he would be held in perpetual suspense between the two? No; he would instantly and with alacrity take up one of them, without feeling the least regret for the want of the other. This action would, indeed, be the consequence of a very powerful motive, the desire to obtain honestly that wealth of which he and his family stood so much in need. That motive, however, being general, would draw him equally to both bags; and it remains with the necessarians to say by what else than a self-determining power he could take either the one or the other. When it is affirmed, that such self-determination would be an effect without a cause, the advocates for liberty cannot help thinking that their antagonists are guilty of advancing as an argument a *petitio principii*; for the affirmation is true, only if the mind in volition be inert, and the *inertia* of the mind is the sole question at issue. If the mind be not inert, it is plain, that in consequence of a man's self-determination, no effect would be produced without

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a sufficient cause. At any rate, motives cannot be causes. In the proper sense of the word, a cause is that which produces an effect; but the production of an effect requires active power; and power being a quality must be the quality of some being by whom it may be exerted. Power may be dormant, and therefore power without will produces no effect. Are motives, then, real beings, endowed with power and will? No; they are only views of things or mental conceptions, which in the strictest sense of the word are passive; and between two motives the mind determines itself, without receiving an impulse from either.

Nor is it only between motives of equal force that men have the power of determining themselves. Whoever believes in a future state of rewards and punishments, and yet acts in a manner which he knows to be offensive to Him who is to be the future and final judge, unquestionably prefers to the strongest of all motives, another which even to himself appears to have comparatively but very little strength. Whether there be men who occasionally act in this manner, is a question which can be decided only by an appeal to every one's consciousness. That there are, we can have no doubt; for we never met with a single individual, not biassed by system, who was not ready to acknowledge, that during the course of his life he had done many things, which at the time of action he clearly perceived to be contrary to his true interest. Without a self-determining power in the mind, this could never be the case. Did motives operate with the necessity of physical causes, it is obvious that in every possible situation the strongest must constantly prevail; and that he who in certain circumstances had in time past done any particular thing, would on a return of the same circumstances do the very same thing in every time future. Dr Priestley, indeed, wishes to persuade his readers that this is actually the case. "In every determination of the mind (says he), or in cases where volition and choice are concerned, all the previous circumstances to be considered are the *state of mind* (including *every thing belonging to the will itself*), and the various views of things presented to it;" and he affirms, that "when- ever the same precise circumstances occur twice, the very same determination or choice will certainly be made the second time that was made the first." This is an assertion of which no man can controvert the truth; for it is an identical proposition. If in the circumstances previous to the determination of the mind, *every thing* belonging to the *will itself* must be included, it is self-evident that he who in any given circumstances has acted a particular part, will on a return of these circumstances act the same part a second time; for this is only saying, that he who on two different occasions shall exert volitions of the same tendency, will not on these occasions exert volitions of which the tendencies are different. But the question to be decided is, Whether a man, in the same general state of mind, possessed of the same degree of health, and conscious of the same appetites, must, in external circumstances perfectly alike, necessarily exert at all times the same volitions. That the human mind is under no such necessity, we think every man's consciousness and experience may abundantly satisfy him; for there are, perhaps, but very few who have not at

one time resisted temptations, to which at another they have chosen to yield.

That there is a relation between motives and actions, must be confessed; but that relation is neither *necessary*, nor constant conjunction. If it were, all actions would be perfectly rational; and folly, as well as merit and demerit, would be banished from the conduct of men. What is the particular nature of that relation which subsists between the voluntary actions of men, and the motives from which they proceed, can be known to every individual only by an attentive and unbiassed reflection on the operations of his own mind. Without this reflection, no man can be made to understand it by the reasonings of philosophers, and with it no man can need the aid of those reasonings. That a self-determining power, such as that for which we plead, contributes to the sum of human happiness, has been shown by Archbishop King and his ingenious translator; who have proved, with the force of demonstration, that the mind can take pleasure in the object of its choice, though that object be in itself neither agreeable nor disagreeable to our natural appetites; and that if it could not, it would be vain in such a world as ours to hope for any portion of felicity. Into that detail our limits will not permit us to enter: but to the reader who wishes for further information, we beg leave to recommend the last edition of King's *Origin of Evil*, by Dr Law late bishop of Carlisle; without, however, vouching for the truth of all the opinions advanced by either of those learned writers.

Before we conclude this chapter, it may be proper to observe, that it is only in volition that we are conscious of any original active power in ourselves, and that without such consciousness we could never have acquired the *notion* of active power. In our desires and appetites, we neither are active nor suppose ourselves active. Lord Kames, and most necessarians, confound desire with volition; but that they are perfectly distinct is plain from this circumstance, that we daily *desire* many things which we know to be wholly out of our own power*, whereas no man ever *willed* what he did not believe to be in his own power. We all *desire* or wish that our children may be virtuous, wise, and happy; and though we are conscious that it is not in our power to make them so, we cannot banish the desire from our breasts. But madmen only have ever *willed* virtue, wisdom, and happiness, to any person; and if there was ever a man so extravagantly mad as to exert such a volition as this, he has at the time fancied himself a divinity, and therefore believed that the object of his volition depended upon himself. When the astronomer, whose character is so admirably drawn by our great master of moral wisdom†, fancied himself the regulator of the weather and the distributor of the seasons, he might *will* either *rain* or *sunshine* as he thought proper, because he considered the object of his volition as depending upon a power imparted to him from heaven; but though he might *desire*, he could not *will*, the rising or the falling of *winds*, for these he confessed were not subjected to his authority. In a word, without freedom in volition, power is inconceivable; and therefore it is as certain that we are free agents, as that we have any notion of active powers.

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If they did,
as merit
and demerit
would be banished
from the
world.

* Reid's
Essays on
the Active
Powers, &c.

† Ruffelas
Prince of
Abyssinia.

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ing and At-
tributes of
God.

CHAP. VI. *Of the BEING and ATTRIBUTES
of GOD.*

It has been already observed, that as of bodies there are various kinds, endowed with various properties; so the probability is, that of minds endowed with different powers, or different degrees of power, the variety may be as great, or perhaps greater. The existence and powers of our own minds are made known to us by consciousness and reflection; and from our dependent state, and the mutability of the objects around us, we are necessarily led to infer the existence of another mind, which is independent, unchangeable, eternal, and the cause of all things which have a beginning of existence. Between that mind and our own, we can hardly avoid believing that there are many orders of "thrones, dominations, principedoms, virtues, powers;" but as we have no intuitive knowledge of such intermediate beings, and cannot form any thing which we perceive discern the necessity of their existence, they are not properly the objects of science. The existence, however, and many of the attributes of One First Cause, are capable of the strictest demonstration; "for the invisible things of Him from the creation of the world are clearly seen, being understood by the things which are made."

Of this great truth, the most important by far which can occupy the mind of man, many demonstrations have been given both by divines and by philosophers. We shall lay before our readers such a one as to us appears perfectly conclusive, being founded on the intuitive knowledge which we have of our own existence, and therefore independent of all theories about the nature and reality of the material world.

Every man, whether he adopt the common theory or that of Berkeley respecting matter, is conscious that he *himself* exists, and must therefore grant that *something now* exists. But if any thing exist *now**, then must something have *always* existed; otherwise that thing which *now* exists, must either have been created by *nothing*, i. e. have been *caused by no cause*, or else it must have *created itself*, acting before it existed. Both these suppositions are so palpably absurd, that no atheist has avowed them, either among the ancients or the moderns. We must therefore admit, either that there is some one *independent* being, which now exists, and always has existed; or that the things which we know to exist at present (every man's *self* for instance), were produced by *something* which had its *existence* from *something else*, which also depended upon *some other cause*, and so on in an *infinite series of caused or successive beings*. But this last supposition, though it has been often made, is as grossly absurd as either of the two former. For of this infinite series, either *some one* part has *not* been successive to any other, or else *all* the several parts of it have been successive. If *some one* part of it was *not successive*, then it had a *first part*; which destroys the supposition of its infinity (R). If *all* the several parts of it have been successive, then have they all once been *future*; but if they

have *all* been future, a time may be conceived when none of them had existence: and if so, then it follows, either that all the *parts*, and consequently the *whole* of this infinite series, must have arisen from *nothing*, which is absurd; or else that there must be something in the *whole* besides what is contained in *all the parts*, which is also absurd.

As the possibility or impossibility of an infinite series of dependent beings is the main question at issue between the atheists and us, we shall state the preceding reasoning in a manner somewhat different. For this purpose, let us suppose some one to affirm, that the course of generation has had no beginning, and consequently that the number of successive births has been infinite. We would ask such a person, Whether before the birth of Abraham, for example, there had [§] been an infinite series of generations or not? If not, the course of generation must have had a beginning, which is the conclusion for which we contend. But if the series past was infinite, then at the birth of Joseph the great-grandson of Abraham, it is evident, that more generations were past, and that the number then was greater than that which was supposed to be infinite; so that upon this supposition we have a number that is both infinite and not infinite, which is a manifest contradiction. Should it be said that the number of generations was infinite, as well at the birth of Abraham as at the birth of Joseph; it will then follow, that one infinite may be greater than another of the very same kind; and consequently that an infinite may be bounded, i. e. be finite. But should it be alleged, that the number of births at Abraham's was finite, and became infinite when it reached to Joseph's, it will then follow, that one finite number added to another may make an infinite number, which is directly contrary to every possible notion of infinity. We might argue in the same manner against an infinite series of every kind, the very supposition of which involves the most palpable contradictions. See Chap. Of INFINITY and ETERNITY.

From the impossibility of an infinite series it necessarily follows, that there exists, and must have existed from eternity, some one independent being, whose duration cannot be commensurate with succession, and to whom the relation of time is not applicable. Here will some atheists presently imagine, that by the same mode of reasoning they may disprove the existence of God: for do not they who thus destroy the eternity of the world, destroy at the same time the eternity of the Creator? If time itself be not eternal, how can the Deity or any thing else be so?

In urging these questions, it must be taken for granted that time is essential to all existence, and that God cannot be eternal otherwise than by a successive flux of infinite time. But it has been already shown (n° 225), that successive duration is not essential to existence; that we can even *conceive* existence without succession; and it may here be added, that if we suppose a perfect being alone in nature, we shall find it impossible to imagine any *succession of ideas*, any *flux of moments*, or any *alteration or increase* whatever in his knowledge and essence.

(R) Ταυταπειρω ουκ εστιν ουδεν πρατον, *Arist. Phys. lib. viii. cap. 5. sect. 4.*

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The existence of God capable of demonstration.

* See Notes to King's Origin of Evil.
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Some one independent Being has existed from eternity.

§ See an Essay towards an Eviction of the Being and Attributes of God, by Seth Ward—Printed at Oxford, 1655.

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Whose duration is not commensurate with succession, and

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essence. Such duration as we are acquainted with can have no relation to an immutable Being, while supposed to exist alone; but as soon as he determined to exercise his several attributes in the production of something distinct from himself, then, and not till then, have we reason to think that *time, succession, and increase*, began. These atheistical questions, therefore, instead of containing an objection to the existence of a Deity, afford a plain demonstration of it: for since it is not more evident that something now exists than that something must have existed from eternity; and since it has been shown, that neither the world in its present state, nor time, nor any thing capable of change or succession, can possibly be eternal; it follows, that there must necessarily be some Being who, in the order of nature, is before time, and who, in the stability and immutable perfection of his own intelligence, comprehends at once his *yesterday, to-day, and for ever*. "The atheists (says the excellent Cudworth*) can here only smile, or make wry faces, and show their little wit in quibbling upon *nunc-stans*, or a *standing now of eternity*; as if that *standing eternity* of the Deity (which with so much reason hath been contended for by the ancient *genuine theists*) were nothing but a *pitiful small moment of time standing still*, and as if the duration of all beings whatsoever must needs be like our own: whereas the duration of every thing must of necessity be agreeable to its nature; and therefore, as that whose *imperfect nature* is ever *flowing* like a river, and consists in *continual motion and changes* one after another, must needs have accordingly a *successive and flowing duration*, sliding perpetually from *present* into *past*, and always hastening on towards the *future*, expecting something of itself which is not yet in being; so must that whose perfect nature is *essentially immutable* have *permanent and unchanging duration*, never losing any thing of itself once present, nor yet running forward to meet something of itself which is not yet in being."

* Intellectual System, Book i. chap. 3.

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291 cannot cease to be.

§ Notes to King on Evil, and Law's Inquiry into the Ideas of Space, &c.

292 What is meant by necessary existence.

From the eternity of the supreme Being we necessarily infer his independence or self-existence; for that which never had a *beginning* of existence cannot possibly have any cause of that existence, or in any manner depend upon any other being, but must exist of itself, or be *self-existent*.

Eternity *ad partem post*, or *necessary existence*, or the impossibility of ever ceasing to be, follows from independence: For to the nature of that which exists without any cause, existence must be essential. But a being whose existence is of itself and essential to its nature, cannot be *indifferent* to existence or non-existence, but must exist *necessarily*. And here it may be proper to observe, that the word *necessity*, when applied to existence, may be taken in two acceptations very different from each other §; either as it arises from the relation which the existence of that thing, of which it is affirmed, has to the existence of *other things*; or from the relation which the *actual* existence of that thing has to the *manner* of its *own* existence.

In the former sense, when necessity of existence has relation to the existence of other things, it denotes that the supposition of the *non-existence* of that thing of which necessity is affirmed, implies the non-existence of things which we *know to exist*. Thus, some independent being does *necessarily exist*; because, to suppose *no independent being*, implies that there are *no de-*

Nº 215.

pendent beings; the contrary of which we know to be true.

In the second sense, when the necessity of existence arises from the relation which the actual existence of any thing has to the *manner* of its own existence, necessity means, that the thing, of which it is affirmed, exists after such a manner as that it never could in *time past* have *been non-existent*, or can in *time future* *cease to be*. Thus, *every independent being*, as it exists without a cause, is *necessarily* existing; because existence is *essential* to such a being; so that it never could *begin* to exist, and never can *cease to be*: For to suppose a being to begin to exist, or to lose its existence, is to suppose a *change* from non-entity to entity, or *vice versa*; and to suppose such a change is to suppose a cause upon which that being depends. Every being, therefore, which is independent, *i. e.* which had no cause of its existence, must exist *necessarily*, and cannot possibly have begun to exist in time past, or cease to be in time future.

These two kinds of necessity as applied to existence, though they have been often confounded, are in themselves perfectly distinct: For though a being cannot be necessarily existent in the *former* sense without being so in the latter also; yet may it be necessarily existent in the latter sense without being so in the former. For any thing that we know to the contrary, there may be two or more beings existing *necessarily* in the latter sense of the word *necessity*, *i. e.* with regard to *independence* and the *manner* of their own existence: but in the former sense of the word, *i. e.* in relation to *this system*, there can be but *one necessarily* existent being; for it is obvious that no more are necessary to account for the production of the *dependent* beings which we know to exist. To suppose the non-existence of *all independent* beings, implies the non-existence of all dependent beings, ourselves and every thing else; but to suppose the non-existence of all independent beings except *one*, involves in the supposition no such absurdity.

Thus the phenomena of nature leads us, by the strictest reasoning, to one first cause, which is sufficient for their production; and therefore none but *one* first cause can in this sense of the word be *necessary*: And though several mere *independent* beings might possibly exist, yet they would be no gods to us: they would have no relation to us demonstrable by reason, nor we any thing to do with them. For if the supposition of their existence were not requisite to the production of this system, which it obviously would not be, we could *perceive* no necessity for it at all; we could never discover it by our own faculties, and therefore it could be nothing to us. And tho' two or three such beings should exist, and act in the formation and government of their *respective* systems, or *agree in one*; yet till their existence and operations were made known to us, and a natural relation discovered, nothing would be due from us to them. They would have no *religious* or *moral* relations to us; and we should have no reason to call more than one of them *our* creator, preserver, and governor, which is the proper sense of the word *God*.

To show in this manner that there is only *one* eternal self-existent Being which bears the relation of *God to us*, seems to be going as far as is necessary, or as natural

293 Only one necessarily-existent being in the former sense; and

294 though there might be more than one in the latter, they would be no gods to us.

Of the Being and Attributes of God.

295
Impossible to demonstrate that there can be but one self-existent Being.

296
Dr Clarke's first demonstration of the unity

* Demonstration of the Being and Attributes of God, Prop. 7.

297
examined, and shown to be inconclusive.

* Dissertation on the Argument a priori, added to *Laws*, Inquiry into the Ideas of Space, Time, Immensity, &c.

tural light will lead us. Those who endeavour to demonstrate that there cannot possibly be more than one self-existent Being, either reason in a circle, or proceed upon principles which their antagonists cannot be compelled to grant. When they deduce the Divine unity from independence or omnipotence, they evidently presuppose it in their definition of these attributes: and when they infer it from the nature of space and duration, which they consider as modes of the self-existent Being, they take it for granted, that space and duration have a real existence, independent of us and our thoughts; and that the one is infinite and the other eternal, contrary to what has been already proved, we think, with the force of demonstration. The celebrated Dr Clarke made much use of space and duration in his attempt to demonstrate that there can be but one self-existent Being; but he argues for the same thing from the nature of necessity as applied to existence.

“Necessity (says he *), absolute in itself, is simple and uniform and universal, without any possible difference, difformity, or variety, whatsoever: and all variety or difference of existence must needs arise from some external cause, and be dependent upon it, and proportionable to the efficiency of that cause, whatsoever it be. Absolute necessity, in which there can be no variation in any kind or degree, cannot be the ground of existence of a number of Beings, however similar and agreeing: because, without any other difference, even number is itself a manifest difformity or inequality (if I may so speak) of efficiency or causality.”

Such is this great man's first argument from necessity, to prove that there cannot be more than one self-existent Being. But what is this necessity which proves so much? It is the ground of existence (he says) of that which exists of itself; and if so, it must, in the order of nature, and in our conceptions, be antecedent to that being of whose existence it is the ground. Concerning such a principle, there are but three suppositions which can possibly be made; and all of them may be shown to be absurd and contradictory. We may suppose either the substance itself, some property of that substance, or something extrinsic to both, to be this antecedent ground of existence prior in the order of nature to the first cause.

One would think, from the turn of the argument which here represents this antecedent necessity as efficient and causal, that it were considered as something extrinsic to the first cause*. Indeed if the words have any meaning in them at all, or any force of argument, they must be so understood, just as we understand them of any external cause producing its effect. But as an extrinsic principle is absurd in itself, and is besides rejected by Dr Clarke, who says expressly, that “of the thing which derives not its being from any other thing, this necessity or ground of existence must be in the thing itself,” we need not say a word more of the last of these suppositions.

Let us then consider the first; let us take the substance itself, and try whether it can be conceived as prior or antecedent to itself in our conceptions or in the order of nature. Surely we need not observe that nothing can be more absurd or contradictory than such a supposition. Dr Clarke himself repeatedly affirms, and it

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would be strange indeed if he did not affirm, that no being, no thing whatever, can be conceived as in any respect prior to the first cause.

The only remaining supposition is, that some attribute or property of the self-existent Being may be conceived as in the order of nature antecedent to that being. But this, if possible, is more absurd than either of the two preceding suppositions. An attribute is attributed to its subject as its ground or support, and not the subject to its attribute. A property, in the very notion of it, is proper to the substance to which it belongs, and subsequent to it both in our conceptions and in the order of nature. An antecedent attribute, or antecedent property, is a solecism as great, and a contradiction as flat, as an antecedent subsequent or subsequent antecedent, understood in the same sense and in the same syllogism. Every property or attribute, as such, presupposes its subject; and cannot otherwise be understood. This is a truth so obvious and so forcible, that it sometimes extorts the assent even of those who upon other occasions labour to obscure it. It is confessed by Dr Clarke†, that “the scholastic way of proving the existence of the self-existent Being from the absolute perfection of his nature, is *ὁσις ἢ ἀποσις*. For all or any perfections (says he) presuppose existence; which is a *petitio principii*.” If therefore properties, modes, or attributes in God, be considered as perfections (and it is impossible to consider them as any thing else), then, by this confession of the great author himself, they must all or any of them presuppose existence. It is indeed immediately added in the same place, “that bare necessity of existence does not presuppose, but infer existence;” which is true only if such necessity be supposed to be a principle extrinsic, the absurdity of which has been already shown, and is indeed universally confessed. If it be a mode or property, it must presuppose the existence of its subject, as certainly and as evidently as it is a mode or a property. It might perhaps a posteriori infer the existence of its subject, as effects may infer a cause; but that it should infer in the other way a priori is altogether as impossible as that a triangle should be a square, or a globe a parallelogram.

Doubtful, as it would seem, of the force of his first argument, which even those who pretend to be convinced by it acknowledge to be obscure, the Doctor gives a second, which we must confess appears to us to be still more obscure, and if possible less conclusive. “To suppose two or more distinct beings existing of themselves necessarily and independent of each other, implies (he says) this contradiction, that each of them being independent from the other, they may either of them be supposed to exist alone; so that it will be no contradiction to suppose the other not to exist; and consequently neither of them will be necessarily existing. Whatsoever therefore exists necessarily is the one simple essence of the self-existent Being; and whatsoever differs from that is not necessarily existing, because in absolute necessity there can be no difference or diversity of existence.

“Necessity is used here in two different senses†, both as absolute and relative. In the former, neither of the two beings can exist without the other, i. e. without our supposing the other to exist also, since that is equally necessary. In the latter, either of them may

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exist

Of the Being and Attributes of God.

† Answer to the Sixth Letter.

298
A second demonstration of the same author.

† *Laws*'s Inquiry into the Ideas of Space, &c. chap. 6.

Of the Being and Attributes of God.

299 examined, and shown to be equally inconclusive.

exist alone, *i. e.* without the help of the other, or without the supposition of the other as requisite to its own existence. The consequence therefore that either of them may exist alone, and so neither of them is necessary, is a mere *equivocation* on *necessity*, using it both in an absolute and relative sense at the same time." But as this is a question of the highest importance, and as the author was a man of great worth, we shall consider his argument upon the supposition that the word *necessity* has from the beginning to the end of it the same invariable meaning.

It has been already observed, that there are only two senses in which that word can be applied to the existence of any being; and whether it be here used in the one or the other of these senses, the reasoning, if resolved into a syllogism, will appear to be inconclusive. If the word be taken in that sense of necessity which arises from the relation that dependent beings which we know to exist bear to some one independent Being, the argument will stand thus:

From a known effect no more causes can be *necessarily* inferred than what are sufficient to account for that effect: but

One self-existent and independent Being is sufficient to account for all the phenomena of nature; therefore, from the phenomena, &c.

No more than one such Being can be *necessarily* inferred to exist.

But though no more than one independent being can in this sense of the word *necessarily* exist, it by no means follows from this syllogism, that two or more such beings may not *possibly* exist. It is, indeed, a plain contradiction to say, that two or more self-existent beings are in this sense *necessary*; but surely there is no contradiction in saying, that two or twenty such beings are *possible*. We could not, therefore, by this argument, convict a person of absurdity, who should affirm that two or more independent beings *actually* exist. We might, indeed, deny the existence of them all but one, because one is sufficient to account for those phenomena, from which alone we know that *any* independent being exists; but because one of them might be supposed to exist *alone*, so that it would be no contradiction to suppose the other not to exist; we know not how the Doctor came to affirm, in direct opposition to his own demonstration, that *not one* of them would be *necessarily* existing.

Necessity, as applied to existence, in the other sense of the word, arises, as we have seen, from the relation which the *actual* existence of the being, of which it may be affirmed, has to the *manner* of that being's existence. It is the same necessity, we are told*, with that which is the *cause* of the unalterable proportion between two and four; and it is considered as the *formal cause* or *ground* of the existence of an independent being. Were it not for the strange expressions *formal cause* and *ground of existence*, we should have no objection to this account of that *necessity* by which a being independent undoubtedly exists: but this kind of necessity is a principle which will not support the superstructure which the learned author labours to raise upon it. The same *necessity* which is the cause of the unalterable proportion between *two* and *four*, is likewise the cause of the unalterable proportion between *three* and *six*, between *four* and *eight*, and be-

tween *five* and *ten*, &c. But if it can be the cause of so many different proportions of the same kind, why may it not be the *formal cause* or *ground* of existence to as *many independent beings* of the same kind as well as to *one*? The following syllogism, we apprehend, to be legitimate both in mode and figure, and its conclusion is directly contrary to the proposition which the Doctor deduces from the same notion of necessity.

If necessity, considered as a *formal cause* or *ground of existence*, be in *one instance* of its causality the *formal cause* or *ground of existence* to *many things* of the same kind, it may likewise in *every other instance* of its causality, be the *formal cause* or *ground of existence* to many things of the same kind.

But such necessity, in that instance of its causality where it is the *formal cause* or *ground of existence* to the unalterable proportion between two and four, is the *formal cause* or *ground of existence* to *many proportions* of the same kind.

Therefore, the same necessity in that other instance of its causality, where it is said to be the *formal cause* or *ground of existence* to *one independent being*, undoubtedly may be the *formal cause* or *ground of existence* to *many independent beings* of the same kind.

Thus it appears, that *necessity*, in any sense in which it can be properly affirmed of existence, cannot be the foundation of any argument to prove the impossibility of more than one self-existent being. It is indeed a principle from which we apprehend that no positive conclusion whatever can be deduced by reasoning *à priori*. That necessity of existence may be predicated of a being which is independent and uncreated, is self-evident; because to the *nature* of such a being, existence is essential. But whilst *that nature* itself remains wholly *incomprehensible* by us, it is impossible that we should discover, by our own unassisted reason, whether it can be the nature of *only one* or of *more than one* independent being. To argue from necessity, as if it were the cause or ground of existence to such a being, is certainly absurd, if it be not impious; for if that to which existence is essential, does not exist without any cause efficient or formal, we shall be obliged to inquire after a cause or ground of this cause, and thus be involved in all the absurdities and contradictions of an infinite series. We have insisted the longer on this point, because *necessity*, as the foundation of the argument *à priori*, has sometimes been employed to very bad purposes. Attempts have been made from the notion of *necessary* existence, to prove that the Supreme Being cannot be a free agent, and to set the first principles of the religion of nature at variance with those which are revealed in the scriptures.

But though we are firmly persuaded that the divine unity cannot be *demonstrated à priori*, we are far from thinking it incapable of any *proof*. On the contrary, the common arguments *à posteriori* drawn from the *order* and *harmony* of the world, have always satisfied us, and in our opinion must satisfy every person capable of proportioning his assent to evidence, that the Creator and Preserver of such a system has but *one will* and *one intelligence*, and therefore is himself but *one being*. But *proof* is one thing; and *demonstration* is, in the proper sense of the word, another.

Of the Being and Attributes of God.

300 Necessity, a dangerous principle.

301

The unity of God highly probable.

* Answer to the Sixth Letter, from a Gentleman in Gloucestershire.

Of the Being and Attributes of God.

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God omnipotent.

† Notes to King or Evil.

ther (G). And if we cannot arrive at *absolute* certainty concerning this important truth by the light of nature, we ought to be the more thankful for that revelation, which has put the unity of God past disputes to all who believe the holy scriptures.

The being which is self-existent and independent must be also *omnipotent*. That such a being has *active power in some degree*, is shown at the same time and by the same medium that we prove his existence; and since he depends upon no cause for his existence or his power, he cannot depend upon any for the exertion of that power, and consequently no *limits* can be applied to it. Limitation is an *effect* of some *superior cause*, which in the present instance there cannot be: consequently to suppose *limits* where there can be no *limiter*, is to suppose an *effect* without a *cause*. For a being to be *limited* or *deficient* in any respect †, is to be *dependent* in that respect on some *other* being which gave it just so much and no more; consequently that being which in *no respect* depends upon any other is in *no respect* limited or deficient. In all beings capable of increase or diminution, and consequently incapable of *perfection* or *absolute infinity*, *limitation* or *defect* is indeed a necessary consequence of existence, and is only a *negation* of that perfection which is wholly incompatible with their nature; and therefore in these beings it requires no further cause. But in a being *naturally capable* of *perfection* or *absolute infinity*, all *imperfection* or *finiteness*, as it cannot flow from the *nature* of that being, seems to require some *ground* or *reason*; which reason, as it is foreign from the being itself, must be the effect of some other external cause, and consequently cannot have place in the *first cause*. That the self-existent being is *capable* of *perfection* or *absolute infinity* must be granted, because he is manifestly the subject of one infinite or perfect attribute, viz. *eternity*, or *absolute invariable existence*. In this respect his existence has been shown to be perfect, and therefore it may be perfect in every other respect also. Now that which is the subject of one infinite attribute or perfection, must have all its attributes infinitely or in perfection; since to have any perfections in a finite limited manner, when the subject and these perfections are both *capable* of *strict infinity*, would be the forementioned absurdity of positive limitation without

a cause. To suppose this eternal and independent being limited in or by its own *nature*, is to suppose some *antecedent nature* or *limiting quality* superior to that being, to the existence of which no *thing*, no *quality*, is in any respect *antecedent* or *superior*. And to suppose that there is no such thing as *active power* in a being which is evidently the fountain of all power, is the grossest of all absurdities. The same method of reasoning will prove knowledge and every other perfection to be *infinite* in the Deity, when once we have proved that perfection to belong to him at all; at least it will show, that to suppose it limited is unreasonable, since we can find no manner of *ground* for limitation in any respect; and this is as far as we need go, or perhaps as natural light will lead us.

Of the omnipotence of the supreme Being some philosophers, as well theists as atheists, have talked very absurdly. *Hobbes* ||, with a view to make this attribute appear impossible and ridiculous, affirms "that God by his omnipotence or infinite power could turn a tree into a syllogism." And *Des Cartes* *, though certainly no atheist, childishly asserts, that all things whatever, even abstract truth and falsehood, do so depend upon the arbitrary will and power of God, as that if he had pleased "twice two should not have been four, nor the three angles of a plain triangle equal to two right ones." But the true notion of Omnipotence, so far from implying a power to turn a tree into a syllogism, or to make twice two not equal to four, implies only that the being possessed of it can actually perform whatever can be conceived by the most perfect understanding; conception in this case being the measure of possibility. Now every thing may be conceived by a mind sufficiently enlarged which does not involve in it a direct contradiction; but what we clearly discern to imply a contradiction, such as that a thing may be and not be at the same instant, cannot be conceived by any intellect, or made to exist by any power. And thus has this attribute of the Divinity been always stated, not only by the wiser Christians, but also by most of the ancient philosophers themselves, who expressly admit that "nothing is exempted from the divine power, but only to make that which hath been done to be undone." (H)

And here it may be asked, Whether creation, in
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Of the Being and Attributes of God.

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Omnipotence can do every thing which does not imply a contradiction. *Leviath. chap. 3. Respons. ad Objectiones Sextas, § 6.*

(G) John Gerhard and John Vossius both cite *Gabriel Biel* as acknowledging the unity of God to be incapable of rigid demonstration; and with the sentiments of that schoolman, those two learned divines profess their own to agree.

Sed Biel (1. Sant. Dist. 2. Q. 10. Art. 3.), statuit "quod tantum unum esse Deum, sit creditum et non-demonstratum ratione naturali nobis in via possibili." Id nos ita interpretamur; etiamsi ex *natura libri* rationes non contemnendæ pro unitate divinæ essentiae asserenda erui possint, eas tamen ad fidei *πληροφορίαν* cordibus nostris ingenerandam, non satis efficaces esse. Ergo mens prius confirmanda est ex *verbo Dei*, et illustribus testimoniis in quibus se Deus generi humano patefecit: Postea utiliter potest addi consideratio philosophicarum demonstrationum. *Gerhard. Loc. Comm. Tom. I. p. 106.*

Dissentit *Gabriel Biel*, qui ante annos hosce 140 *Tubingensi* Gymnasio præfuit. Is censet *probabiles* magis rationes esse quam *evidentes* et *certain*.—Verum esto sane, ut solæ non sint *αποδεικνύουσαι*: At magnum iis pondus addit *traditio* vetus; tum autem quod argumenta isthæc, si non prorsus *αποδεικνύουσαι*, saltem usque adeo *probabilia* sint, ut *της πολυβίας* patroni nihil ullius momenti adferre valeant; cur plusquam unum statuere deum potius conveniat. *Voss. de Idolatria, Lib. I. c. 2.*

(H) το δε γεγονός ουκ ενδεχεται μη γενεσθαι· διο αγαθως αγαθων.
Μονου γαρ αυτου και θεος σερισκεται,
Αγεννητα ποιειν, ας αν η πεπραγμενα.

Arist. ad Nicomach. Lib. 6. cap. 2.

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Creation possible to Omnipotence.

† See Mo-
seim's Dis-
sertation on
this Subject,
in his Edi-
tion on Cud-
worth's In-
tellectual
System.

the proper sense of the word (see CREATION), be within the compass of infinite power. All the ancient philosophers, who were unenlightened by the rays of divine revelation, held that it is not †; grounding their opinion upon this maxim, *Ex nihilo nihil fit*. But the maxim will support no such conclusion.—The ancients, or at least the Peripatetic school, with the metaphysics of which we are best acquainted, considered four kinds of causes, the *efficient*, the *material*, the *formal*, and the *final*; and though they extended the maxim to the first two, if not to all these causes, it is a self-evident truth only when applied to the *efficient cause*. Without the actual exertion of *power*, it is indeed most certain that nothing could be brought into existence; but it is so far from being clear that pre-existent matter, or, as Aristotle chose to express himself, a *material cause*, must be supposed for infinite power to operate upon, that, we think, every man may find complete evidence of the contrary in himself. That sensation, intelligence, consciousness, and volition, are not the result of any modifications of figure and motion, is a truth as evident as that consciousness is not swift, nor volition square. If then these be the powers or properties of a being distinct from matter, which we think capable of the completest proof, every man who does not believe that his mind has existed and been conscious from eternity, must be convinced that the power of creation has been exerted in himself. If it be denied that there is any immaterial *substance* in man, still it must be confessed, that, as matter is not essentially conscious, and cannot be made so by any particular organization, there is some real *thing* or *entity*, call it what you please, which has either existed and been conscious from eternity, or been in time brought from non-entity into existence by an exertion of infinite power.

To this perhaps some one may object, that upon our own supposition of the inability of the human mind to exert its faculties but in union with some material and organised system, the mind of every man may have existed from eternity without being conscious of its own existence; and that, therefore, we have in ourselves no evidence of *creation*, but only of the union of two self-existent substances, which in their prior state had been distinct and separate from each other. But such an objection as this, we beg leave to reply, can arise from nothing but misapprehension of our hypothesis, and of the reasons by which we think it supported. We suppose, that to the exertion of the human faculties, a body of some kind or other may be necessary as an instrument, not merely from what we observe of the dependence of perception and memory on the state of the brain, but because we cannot conceive a Creator of infinite wisdom and goodness to immerse in systems of matter, minds to which he knows that such systems must be always useless and often hurtful. We believe, therefore, that our souls and bodies were created and formed for each other; but as our present adversaries admit not of a Creator, we must ask them, How their self-existent souls have been disposed of from eternity, and by what power they have all in due succession been united each to its proper body? As before the union they were not conscious, they could not unite themselves; and to suppose them united by some superior intelligence,

is to suppose them in some respects dependent on that intelligence, which seems not to accord with their self-existence. Whatever is self-existent and eternal must be independent; and if possessed of any power, cannot be conceived to have that power limited.—We repeat, therefore, that every man has in himself sufficient evidence that creation is possible; for if infinite power can create an immaterial and percipient being, it may surely be supposed capable of creating dead and unintelligent matter.

But the creation of the material system may be shown to be in the highest degree probable by other arguments. The same reasoning which proves the impossibility of an infinite series and of eternal time, proves that the universe cannot have existed from eternity in its present state. But if it has not existed from eternity in its present state, it belongs to the opponents of creation to say what was its former. We talk indeed of *chaos*; but such language, when a Creator is not admitted, is most unphilosophical trifling. It appears from the most accurate inquiries that have been made into the substance and essence of body †, that the atoms of which each mass is composed are held together by a foreign force. If by *chaos* be meant matter, when this force is supposed to be removed, we must beg leave to say, that of such a substance we have neither idea nor notion, and cannot distinguish it from non-entity. The original atoms of matter, we believe indeed to require no other agency to keep each entire than that *fiat* by which it was created; but still, as those atoms are conceived to be solid and extended, they must be capable of division by infinite power; and if that *fiat* or influence which makes them solid and extended were removed, they would lose solidity and extension, and of course become nothing. So far is it, therefore, from being true, that the creation of matter appears to be impossible, that we are compelled by every thing that we know of it to believe that matter cannot possibly be self-existent.

“Because it is undeniably certain, concerning ourselves (says Cudworth †), and all imperfect beings, that none of these can create any *new substance*, men are apt to measure all things by their own scantling, and to suppose it universally impossible for any power whatever thus to create. But since it is certain, that imperfect beings can themselves produce *some things* out of nothing pre-existing, as *new cogitations*, *new local motion*, and *new modifications* of things corporeal, it is surely reasonable to think that an absolutely perfect Being can do *something more*, i. e. create *new substances*, or give them their whole being. And it may well be thought as easy for God or an Omnipotent Being, to make a whole world, matter and all, *ἐκ οὐκ οντων*, as it is for us to create a *thought* or to move a finger, or for the sun to send out rays, or a candle light; or lastly, for an opaque body to produce an image of itself in a glass or water, or to project a shadow: all these imperfect things being but the *energies*, *rays*, *images*, or *shadows*, of the Deity. For a substance to be made out of nothing by God, or a Being infinitely perfect, is not for it to be made out of nothing in the impossible sense, because it comes from him who is *all*. Nor can it be said to be impossible for any thing whatever to be made by that which

hath

Of the Being and Attributes of God.

† Baxter's Inquiry into the Nature of the Human Soul.

† Intellectual System, Book i. Chap. 5.

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nath not only *infinitely greater perfection*, but also *infinite active power*. It is indeed true, that infinite power itself cannot do things in their own nature impossible; and, therefore, those who deny creation, ought to prove, that it is absolutely impossible for a *substance*, though not for an *accident* or *modification*, to be brought from non-existence into *being*. But nothing is in itself impossible, which does not imply a contradiction: and though it be a contradiction for a thing to be and not to be at the same time, there is surely no contradiction in conceiving an imperfect being, which before was not, afterwards to be." To call in question the possibility of creation, because we have no *adequate conception* how a thing can be brought into existence, would be in the highest degree absurd; for it may be doubted, whether we have *adequate conceptions* of any thing except our own ideas and their various relations (1).

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God a free agent; but

The Being which is self-existent, omnipotent, and omniscient, is not a *necessary*, but a *free agent*; for *active power* implies *freedom*, and *infinite power* *infinite freedom*. What, therefore, hath no bounds set to its power, what can have no opposition made to its will, nor restraint laid on its actions, must both will and act freely. "If the supreme cause were not a being endowed with liberty and choice, but a mere necessary agent, then would it follow, as Dr Clarke well observes †, that nothing which is not, could *possibly* have been; and that nothing which is, could *possibly* not have been; and that no mode or circumstance of the existence of any thing could *possibly* have been in any respect otherwise than it now actually is. All which being evidently most false and absurd; it follows, on the contrary, that the supreme cause is not a mere necessary agent, but a Being endued with liberty and choice."

† Demonstration of the Being and Attributes of God.

† Cooper's Truths.

To this reasoning it has been lately replied †, that "Clarke must have known, that all those who contend against the free agency of the Deity, do of course acknowledge, that nothing could have happened, or does happen, or will happen, but what actually has happened, or doth happen, or will happen; and that it is most false and absurd to deny it." It is, therefore, according to the necessarians, absolutely impossible, that at present there could exist upon this earth more or fewer persons than are now actually alive; that the earth could move in any other direction than from west to east; or that there could be more or fewer planets in the solar system. Yet is it most cer-

tain, that there have been fewer persons on the earth than there are now; that there is not a cultivated country in Europe which could not contain *more* people than now inhabit it; that the comets move in very different directions from that of west to east; and that as, till very lately, we conceived only six primary planets in the system, it is evidently *possible* that the system might contain no more. Upon the supposition, therefore, that the Supreme Being acts under a physical necessity, the same things are possible and not possible at the same time, which is the grossest of all absurdities. It might have been objected with much more plausibility, that the first cause cannot possibly be free, because he must needs do always what is best in the whole; but it will be seen by and by, that among different created systems, there is no reason for supposing any one absolutely best.

But though this Being is *free*, and as such the author of *change* in other beings, yet he must himself be *unchangeable*; for all changes have a beginning, and consequently are effects of some *prior causes*. But there can be nothing prior to the existence of this Being, as he is *eternal*; neither any *cause* of it, as he is *independent*; nor consequently any *change* in it, except we could suppose him to *change himself*, which is the same absurdity as to *produce himself*, i. e. to be at the same time both *effect* and *cause*.

Omniscience, as well as some of the foregoing attributes of the Supreme Being, may perhaps be more easily deduced thus §. We find in ourselves such qualities as *thought* and *intelligence*, *power* and *freedom*, &c. for which we have the evidence of consciousness as much as for our own existence. Indeed, it is only by our consciousness of these that our existence is known to ourselves. We know likewise that these are *perfections*, and that to have them is better than to be without them. We find also that they have not been in us from eternity. They must, therefore, have had a *beginning*, and consequently some *cause*, for the very same reason that a *being* beginning to exist in time requires a cause. Now this cause, as it must be *superior* to its *effect*, must have those perfections in a *superior* degree; and if it be the *first cause*, it must have them in an *infinite* or *unlimited* degree, since *bounds*, or *limitation* without a limiter, would, as we have already shown, be an *effect* without a *cause*.

It is indeed obvious, that the *omniscience* of the Supreme Being is implied in his very existence. "For all things being not only present to him, but also entirely

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himself unchangeable.

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Omniscience, &c. proved in a different manner. Notes to King on Evil.

(1) "Ridicula foret et inepta ejus temeritas, qui corporum ideo creationem sibi duceret negandum esse, quod ejus creationis *clarem et perspicuam notionem* effingere cogitatione nobis haud licet. Infinita enim est rerum copia, quarum perspicuis et apertis caremus notionibus. Et si omnia neganda continuo nobis essent, quorum confusam tantum et imperfectam consequi possumus notionem, omnia fere nobis essent neganda, exceptis *relationibus*, quas inter notiones quasdam abstractas esse intelligimus. Quis interiori sibi naturam rerum, tam corporum, quam spirituum, cognitam esse dixerit? Et esse tamen has naturas, omni plane dubitatione vacat. Quis quemadmodum altera harum naturarum agat in alteram, sese scire, affirmet? Quis causas sibi patere, propter quas hi vel illi effectus, quos videmus quotidie contingere, a certis veniant corporibus, jure gloriatur? Nec tamen quisquam est, qui vel illam animæ in corpus operationem, vel hos effectus in dubium revocare audeat. Teneamus igitur ea, quæ certo novimus, nec idcirco nos ab illis dimoveri patiamur, quod multa rursus sunt, quorum naturam ignoramus; contra multa nos fugere et cognitionem nostram superare, æquo et tranquillo feramus animo. Joannis Clerici contra eos qui negant, ex nihilo ulla ratione fieri posse aliquid, observationes; in Mosheimii edit. Intellect. Syst.

Of the Being and Attributes of God.

tirely depending upon him, and having received both their being itself and all their powers and faculties from him, it is manifest that as he knows all things that are, and penetrates every part of their substance with his all-seeing eye, so must he likewise know all possibilities of things, that is, all effects that *can be*. For, being alone self-existent, and having alone given to all things all the powers and faculties with which they are endued, it is evident that he must of necessity know perfectly what all and each of these powers and faculties, which are derived wholly from himself, can possibly produce. And seeing at one boundless view, or more properly in his own ideas, all the possible compositions and divisions, variations and changes, circumstances and dependencies of things, all their possible relations one to another, and their dispositions or fitnesses to certain and respective ends, he must without possibility of error know exactly what is best and properest in every one of the numberless possible cases, or methods of disposing things; and understand perfectly how to order and direct the respective means to bring about what he so knows to be in its kind, or on the whole, the best and fittest in the end. This is what is meant by infinite wisdom, or omniscience †; and it has been readily admitted by every man who has believed in the existence of a God as the creator and preserver of all things.

† Clarke's Demonstration, &c.

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God fore-knows the actions of free agents.

Doubts, however, have been entertained by theists, and pious theists, whether omniscience itself can certainly foreknow what are called contingent events, such as the actions of free agents; and some few there are professing to be even Christians, who have boldly pronounced such knowledge to be impossible. That we have no adequate notion *how* events, which are called contingent, can be certainly foreknown, must indeed be granted; but we are not, therefore, authorised to say that such knowledge is impossible, unless it can be clearly shown to imply a contradiction. They who suppose that it implies a contradiction, must likewise suppose, that, where there is not a chain of necessary causes, there can be no certainty of any future event; but this is evidently a mistake. "For let us suppose that there is in man a power of beginning motion, and of acting with what has of late been called *philosophical freedom*; and let us suppose farther that the actions of such a man cannot possibly be foreknown; will there not yet be in the nature of things, notwithstanding this supposition, the same *certainty of event* in every one of the man's actions, as if they were ever so fatal and necessary? For instance, suppose the man, by an internal principle of motion, and an absolute freedom of mind, to do some particular action *to-day*, and suppose it was not possible that this action should have been foreseen *yesterday*, was there not nevertheless the same *certainty of event* as if it had been foreseen, and absolutely necessary? That is, would it not have been as *certain a truth yesterday*, and from eternity, that this action was in event *to be performed to-day*, notwithstanding the supposed freedom, as it is now a *certain and infallible truth* that it is performed? Mere *certainty of event*, therefore, does not in any measure imply *necessity* †." And surely it implies no contradiction to suppose, that every future event which in the nature of things is *now certain*, may *now be certainly known* by that intelligence which is omniscient. The manner

† Clarke's Demonstration, &c.

how God can foreknow future events, without a chain of necessary causes, it is indeed impossible for us to explain: yet some sort of *general notion* of it we may conceive. "For, as a man who has no influence over another person's actions, can yet often perceive beforehand what that other will do; and a wiser and more experienced man, with still *greater probability* will foresee what another, with whose disposition he is perfectly acquainted, will in certain circumstances do; and an angel, with still *less degrees of error*, may have a further prospect into mens future actions: so it is very reasonable to conceive, that God, without influencing mens wills by his power, or subjecting them to a chain of necessary causes, cannot but have a knowledge of future free events, as much *more certain* than men or angels can possibly have, as the *perfection* of his nature is greater than that of theirs. The distinct manner how he foresees these things we cannot, indeed, explain; but neither can we explain the manner of numberless other things, of the reality of which, however, no man entertains a doubt †." We must therefore admit, so long as we perceive no contradiction in it, that God always knows all the free actions of men and all other beings endued with liberty; otherwise he would know many things now of which he was once ignorant, and consequently his omniscience would receive addition from events, which has been already shown to be contrary to the true notion of infinity. — In a being incapable of change, knowledge has nothing to do with *before* or *after*. To every purpose of knowledge and power, all things are to him equally present. He knows perfectly every thing that is, and what to us is future he knows in the very same manner as he knows what to us is present.

† Clarke's Demonstration, &c.

Thus have we demonstrated the necessary existence of a being who is *eternal, independent, unchangeable, omnipotent, free in his actions, and omniscient*; and this is the being whom we worship as God. *Eternity, independence, immutability, omnipotence, liberty, and omniscience*, which seem to be all the *natural* attributes which we can discover in the divine nature, as they are conceived to be differently combined, make us speak of him in different terms. His enjoying in an absolute manner every conceivable power or perfection, makes us call him a Being *infinitely perfect*. His being capable of no want, defect, or unhappiness of any kind, denotes him to be *all-sufficient in himself*; and the unlimited exercise of his knowledge and power, demonstrates him to be *omnipresent*. That such a Being must be incomprehensible by us, and by every creature, is a truth self-evident; and yet in all ages men of the best intentions have been vainly attempting this impossibility. The manner of his omniscience, for instance, has been the subject of much disputation among those who ought to have reflected that they knew not how their own minds were present to their own bodies. — The celebrated Dr Clarke and his adherents, who considered space as the *sine qua non* of all other things, insisted, that God must be infinitely extended; and that, as wherever his substance is, there his attributes must be, it is thus that his knowledge and power are present with every creature. But this notion labours under insuperable difficulties.

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God infinitely perfect, all-sufficient, and omnipresent.

For "if the Divine substance be infinitely extended, then will there be part of it in this place and part

Of the Being and Attributes of God.

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The manner of the Divine Omnipresence in comprehensible.
† Watts's Essays, and Lord's Inquiry into the Ideas of Space, Time, and Immensity, &c.

Of the Being and Attributes of God.

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God's moral attributes result from his natural-perfections.

in that. It must be commensurate with all particular beings, so that some will occupy more and some less of its dimensions. By this account it will be very proper and philosophical to say, that God is not in *heaven*, but only a *part* of him; and that an *elephant* or a *mountain*, a *whale* or a wicked *giant*, have more of the essence or presence of God with them than the *holiest* or *best* man in the world, unless he be of equal size: all which, as has been well observed †, are at least harsh and grating expressions. As the attributes of the Divine Being must be considered in the same manner with his substance, we shall likewise, upon this notion of omnipresence, have a part of his knowledge and power in this place, and a part of them in that; and of these parts the one must be greater or less than the other according to the dimensions of the place with which it is commensurate; which is a supposition that appears to us harsher, if possible, than even the former.

“Should it be said that the Divine attributes are not to be considered as having parts (though we see not how they can be considered otherwise than as their subject), they must then exist *completely* in every point of this immense expansion. Be it so; and what follows? Why, every point of this infinitely expanded being will be omniscient and omnipotent by itself; an inch of it will have as much wisdom and power as a yard, a mile, or the whole; and, instead of one infinite wisdom and power, we shall have millions: For as these parts of the substance are conceived *distinctly*, and one individual part is not another, so must the attributes be likewise conceived, and the individual power and knowledge of one part be distinct from that of another.” And if so, it follows, that one point of this expanded being has equal power and intelligence with the whole; so that the notion of extension being *necessary* to God's presence with every creature, involves in it the most palpable contradiction. That God is at all times and in all places so present with every creature as to have an absolute knowledge of and power over it, is indeed capable of the strictest demonstration; but we think it great presumption to assign the particular *mode* of his presence, especially such a one as is neither agreeable to the nature of an absolutely perfect Being, nor in the least necessary to the exercise of any one perfection which he can be proved to possess. Philosophers and divines have offered several names for the manner in which God is present with his works; but we choose rather to confess, that the *manner* of his presence is to us, and probably to every creature, wholly incomprehensible. Nor need we be surprised or staggered at this, when we reflect that the manner in which our own minds are present with our bodies is to us as incomprehensible as the manner in which the supreme Mind is present with every thing in the universe. That our minds have a power over our limbs, we know by experience: but that they are not extended or substantially diffused through them, is certain; because men daily lose arms and legs without losing any part of their understanding, or feeling their energies of volition in the smallest degree weakened. But we need pursue this subject no farther. It has been confessed by one of the most strenuous advocates † for the extension of the Deity and all minds, that “there is an incomprehensibility

in the *manner* of every thing, about which no controversy can or ought to be concerned.”

The moral attributes of God may be deduced from his natural ones, and are immediate consequences of them when exercised on other beings. They may be termed his *secondary relative* attributes, as they seem to be the perfection of his *external acts* rather than any *new internal* perfections. And though the existence of any moral quality or action is not capable of strict *demonstration*, because every moral action or quality, as such, depends upon the *will* of the agent, which must be absolutely free; yet we have as great assurance that there are moral qualities in God, and that he will always act according to these qualities, as the nature of the thing admits; and may be as well satisfied of it, as if it were capable of the most rigid demonstration. This important point, however, cannot be so clearly or so firmly established by abstract reasoning as by taking a scientific view of the works of creation, which evince the goodness, holiness, and justice, of their Author, as well as his perfect wisdom and infinite power. The consideration, therefore, of the moral attributes of God, together with his providence, and the duties thence incumbent on man, is the proper business of other articles (see RELIGION, THEOLOGY, and MORAL Philosophy.)

At present we shall only observe, that by reasoning *à priori* from his existence and his natural perfections, we must necessarily infer that his actions are the result of unmixed benevolence. Every wise agent has some end in view in all his actions; it being the very essence of folly to act for no end: but there cannot be an end of action which is not either selfish or benevolent. Selfishness is the offspring of want and imperfection, and is therefore the source of most *human* actions; because men are weak and imperfect beings, capable of daily additions to their happiness. When the thief plunders a house at midnight, when the highwayman robs a traveller on the road, and even when the assassin murders the man who never injured him; it will be found that their actions spring not from an innate desire to inflict misery upon others, but from a prospect of reaping advantage to themselves. The object of the thief and the robber is obvious: it is to gain money, which is the mean of procuring the comforts of life. Even the assassin has always the same selfish end in view: either he is *bribed* to commit the murder, or he fancies that his horrid deed will remove an *obstacle* from the way to his own happiness. But they are not vicious men *only* who act from selfish considerations: much of human *virtue*, when traced to its source, will be found to have its origin in the desire of happiness. When a man gives his money to feed the hungry and to clothe the naked, he believes that he is acting agreeably to the will of Him to whom he and the poor stand in the same relation; and he looks for a future and eternal reward. By continuing the practice, he soon acquires the habit of benevolence; after which, indeed, he looks for no further reward, when performing particular actions, than the immediate pleasure of doing good. This selfishness of man is the necessary consequence of his progressive state. But the Being who is independent, omnipotent, omniscient, and, in a word, possessed of every possible

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perfection, is incapable of progression, or of having any accession whatever made to his happiness. He is immutable; and must of necessity have been as happy from eternity, when existing alone, as after the creation of ten thousand worlds. When, therefore, he willed the existence of other beings, he could have nothing in view but to communicate some resemblance of his own perfections and happiness. That he had *some end* in view, follows undeniably from his infinite wisdom. That he could not have a *selfish* end, follows with equal certainty from his own infinite perfections; and as there is no medium, in the actions of a wise Being, between selfishness and benevolence, we must necessarily conclude, that the creation was the result of unmixed benevolence or perfect goodness. The other moral attributes of the Deity, his justice, mercy, and truth, ought therefore to be considered only as so many different views of the same *goodness* in the *Creator*, and various sources of *happiness* to the *creature*. These are always *subordinate* to and *regulated* by this one principal perfection and brightest ray of the Divinity.

“Thus we conceive his *justice* to be exerted on any being no farther than his goodness necessarily requires, in order to make that being, or others, *sensible* of the *heinous nature* and *pernicious effects* of *sin* §, and thereby to bring them to as great a degree of happiness as their several natures are capable of. His *holiness* hates and abhors all wickedness, only as its necessary consequences are absolute and unavoidable misery; and his veracity or faithfulness seems to be concerned for truth, only because it is connected with and productive of the happiness of all rational beings; to provide the properest means for attaining which great end, is the exercise of his *wisdom*.” Such is the view of God’s moral attributes, which the abstract contemplation of his natural perfections necessarily gives; and whether this way of conceiving them be not attended with less difficulty than the common manner of treating them under the notion of two infinities *diametrically opposite*, must be left to the judgment of the reader.

But if the Creator and supreme Governor of all things be a Being of infinite power, perfect wisdom, and pure benevolence, how came evil into the works of creation? This is a question which has employed the speculative mind from the first dawning of philosophy, and will continue to employ it till our faculties be enlarged in a future state, when philosophy shall give place to more perfect knowledge. To these meditations, as has been well observed †, humanity is not equal. Volumes have been written on the subject; but we believe that the following extract from Dr Clarke contains all that can be advanced with certainty, and all that is necessary to vindicate the ways of God to man.

“All that we call evil (says that able reasoner †), is either an *evil of imperfection*, as the want of certain faculties and excellencies which other creatures have; or *natural evil*, as pain, death, and the like; or *moral evil*, as all kinds of vice. The *first* of these is not properly an evil: for every power, faculty, or perfection, which any creature enjoys, being the free gift of God, which he was no more obliged to bestow than he was to confer being or existence itself, it is plain, that the want of any certain faculty or perfection, in any kind of creatures, which never belonged

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to their nature, is no more an evil to them, than their never having been created or brought into being at all could properly be called an evil.” To this we may add, that as no created being can be self-existent and independent, imperfection is unavoidable in the creation, so that the evil of defect (as it is most absurdly called) must have been admitted, or nothing could ever have existed but God. “The *second* kind of evil, which we call *natural evil*, is either a necessary consequence of the former, as *death* to a creature on whose nature immortality was never conferred; and then it is no more properly an evil than the former: Or else it is counterpoised in the whole with as great or greater good, as the *afflictions and sufferings of good men*; and then also it is properly no evil: Or else it is a *punishment*; and then it is a necessary consequence of the *third* and last sort of evil, viz. *moral evil*. And this arises wholly from the abuse of *liberty*, which God gave to his creatures for other purposes, and which it was reasonable and fit to give them for the perfection and order of the whole creation: only they, contrary to God’s intention and command, have abused what was necessary for the perfection of the whole, to the corruption and depravation of themselves. And thus have all sorts of evils entered into the world without any diminution to the infinite goodness of its Creator and Governor.”

But though evil could not be totally excluded from the universe, are we not authorised to infer, from the infinite power, wisdom, and goodness of the Creator, that the present system is upon the whole the very best system possible? Undoubtedly we are, if of possible systems there *can be a best*; but this is so far from being evident, that we think it implies a contradiction. A best of beings there is, viz. God, who is possessed of infinite perfections; but there cannot be a best of creatures or of created systems. To prove this, we need only reflect, that wherever creation stops, it must stop infinitely short of infinity; and that how perfect soever we conceive any creature or system of creatures to be, yet the distance between that and God is not lessened, but continues infinite. Hence it follows, that the nature of God and his omnipotence is such, that whatever number of creatures he has made, he may still add to that number; and that however good or perfect the system may be on the whole, he might still make others equally good and perfect.

The dispute, whether a being of infinite power, wisdom, and benevolence, must be supposed to have created the *best possible system*, and the embarrassment of mens understandings about it, seem to have arisen from their taking the words *good*, *better*, and *best*, for absolute qualities inherent in the nature of things, whereas in truth they are only relations arising from certain appetites. They have indeed a foundation, as all relations have, in something absolute, and denote the thing in which they are founded; but yet they themselves imply nothing more than a relation of congruity between some appetite and its objects. This is evident; because the same object, when applied to an appetite to which it has a congruity, is good; and bad, when applied to an appetite to which it has no congruity. Thus, the earth and air to terrestrial animals are good elements, and necessary to their preservation: to those animals the water is bad, which yet affords

§ Notes to King on Evil.

313 The origin of evil.

† Johnson’s Review of a free Inquiry into the Origin of Evil.

† Demonstration of the Being and Attributes of God.

314 Whether the present be the best system possible.

315 Origin of that question.

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God not
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worlds.

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No system
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best.

affords the best receptacle to fishes. *Good*, therefore, being relative to appetite, that must be reckoned the best creature by us which has the strongest appetites, and the surest means of satisfying them all, and securing its own permanent happiness. And though the *substance* of creatures is chiefly to be regarded as contributing to their perfection, yet we have no way of measuring the perfection of different substances but by their qualities, *i. e.* by their appetites by which they are sensible of good and evil, and by their powers to procure those objects from which they receive that sense of things which makes them happy.

It is plain, therefore, that whatever system we suppose in nature, God might have made another equal to it; his infinite wisdom and power being able to make other creatures equal in every respect to any that we know or can conceive, and to give them equal or stronger appetites, and as certain or more certain ways of satisfying them. We see in many cases, that very different means will answer the same end. A certain number of regular pyramids will fill a space; and yet irregular ones will do it as well, if what we take from the one be added to another; and the same thing may be done by bodies of the most irregular and different figures in the same manner: and therefore we may very well conceive, that the answering of appetites, which is all the *natural good* that is in the world, may as well be obtained in another system as in this; provided we suppose, that where the appetites of the sentient beings are changed, the objects are also suited to them, and an equal congruity among the parts of the whole introduced. This is so easily conceived, that in an indefinite number of possible worlds, we do not see why it may not be done in numberless ways by infinite power and wisdom.

If then it be plain, that there might have been many other worlds, or even but one, equal to this in all respects as to goodness, there could be no necessity,

either physical or moral, that God should create the one rather than the other; because nothing could make the one better, or to him more agreeable, than the other, but his own free choice. Either, therefore, God must be possessed of absolute freedom, or, among a number of possibilities equally perfect, he could not have made a choice, and so nothing would ever have been created. It is not, then, as Leibnitz and others argue, the natural and necessary goodness of some particular things, *represented by the divine ideas*, which determines God to prefer them to all others, if understood of his *first* act of producing them; but it is his own free choice, which among many equal *potential* goods, makes some things *actually* good, and determines them into existence. When those are once supposed to exist, every thing or action becomes good which tends to their happiness and preservation; and to suppose their all-perfect Author to have any other end in view than their preservation and happiness, is the same absurdity as to suppose that knowledge may produce ignorance; power, weakness; or wisdom folly.

We have now finished what we proposed under the article Metaphysics. It has swelled in our hands to a large extent; and yet it can be considered as little more than an introduction to that science, which comprehends within its wide grasp every thing existing. The reader who wishes to pursue these interesting speculations, should study diligently the authors whom we have consulted, and to whom we have been careful to refer in the margin. Were we to make a selection, we should without hesitation recommend Aristotle and Plato among the ancients; and Cudworth, Locke, Hartley, and Reid, among the moderns. These philosophers, indeed, on many points, differ exceedingly from one another; but he who wishes not to adopt opinions at random, should know what can be said on both sides of every question.

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Metaplas-
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Metastasio.

METAPLASMUS, in grammar, a transmutation or change made in a word, by adding, retrenching, or altering a syllable or letter thereof.

METAPONTUM, or METAPONTIUM, (anc. geog.), a town of Lucania, on the Sinus Tarentinus, to the west of Tarentum; built by the Pylians, who returned from Troy, (Mela). Where Pythagoras is said to have taught in the time of Servius Tullius, (Livy). *Metapontini*, the people; who pretended to show, in a temple of Minerva, the tools with which Epeus built the wooden horse, (Justin). Now a tower, called *Torre di Mare*, in the Basilicata of Naples, (Baudrand.)

METASTASIO (l'abbé Pierre Bonaventure), whose real name was *Trapassi*, was born at Assise, on January 3d, 1698. His talent for poetry was first unfolded by the reading of Tasso; and he began to compose verses at ten years of age. "A prodigy of this nature (says Metastasio) made such an impression on my master, the celebrated Gravina, that he thence-

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forth considered me as a plant worthy of being cultivated by his own hands." Metastasio was only fourteen years of age when he composed his tragedy entitled *Il Giustino*; in which he appears too close and scrupulous an imitator of the Grecian drama. Our young poet unfortunately lost his patron in 1717; who left him his heir, "as being a young man of the most promising abilities." Metastasio, at the age of nineteen, being, in consequence of this inheritance, superior to those wants which repress the exertions of genius, and to which men of abilities are too often subject, gave full scope to his inclination for poetry. He began his dramatic career with the *Didonne Abandonnata*, which was acted at Naples in 1724; the music was composed by Sarro. He soon acquired such celebrity, that in 1729 he was invited to Vienna by the emperor Charles VI.; who appointed him imperial poet, and granted him a pension of 4000 florins. From that time some of his works were presented at every court-festival; and notwithstanding the extreme

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Metastasio. magnificence of these entertainments, they would now be forgotten were it not for the verses which he composed upon the occasion. The courts of Vienna and Madrid vied with each other in the presents which they conferred upon him. From Maria Theresa he received a snuff-box and a port-folio set with diamonds, and a golden candlestick with a screen. Ferdinand VI. king of Spain, informed of the great merit of Metastasio by Farinelli, of whom he was a passionate admirer, sent him a present of a casket mounted with gold, and furnished with the different implements of writing. This favourite of kings and of the muses was of a cheerful temper, and was exceedingly temperate: to this he was probably indebted for the uninterrupted health which he enjoyed, and for the entire possession of his senses and faculties to the most advanced period of old-age. He took his meals, arose, and went to bed, always at stated hours. This exactness and order were scrupulously observed even in the most trifling actions of his life. He used to say in jest, that he dreaded hell for no other reason but because it was a place *ubi nullus ordo, sed sempiternus horror inhabitat*. He had even his stated hours for making verses; to which he scrupulously adhered, without waiting for the moment of poetical enthusiasm. He was equally regular in the duties of the Christian as in the labours of the scholar. His behaviour was that of a true philosopher: his ambition extended no farther than the attainment of literary fame; and he despised every civil mark of distinction. When Charles VI. offered him the titles of *Count* or of *Baron*, which add no real worth or dignity to the possessor, but frequently make him appear in a more ridiculous light, he instantly begged the favour that he would allow him still to continue *Metastasio*. The empress Maria Theresa afterwards wished to bestow upon him the small cross of St Stephen; but he excused himself on account of his age, which would prevent him from assisting at the festivals of the order. He was attacked by a fever on the 2d of April 1782; and he died on the 12th of the same month, at the age of 84. Before his death he received the sacrament according to the form of the Romish church; and Pius VI. who was then at Vienna, sent him his apostolical benediction *in articulo mortis*. He left about 150,000 florins. He composed a great number of tragic operas, and several small dramatic pieces which have been sent to music. We have different editions of them in 4to, 8vo, and 12mo; and M. Richelet has published a translation of them into French, in 12 vols, small 12mo.

The greatest part of Metastasio's writings will confer immortality on their author. His dialogue is natural, simple, and easy; his style is always pure and elegant, and sometimes sublime and pathetic. His subjects are noble, interesting, and excellently adapted for representation. He was perfectly acquainted with the resources of his art, and has subjected the opera to rules. He stripped it of its machinery, and of the marvellous, which was fitted to excite the gaze of astonishment, but which gave no instruction to the understanding, and made no impression on the heart. His descriptions are copied from nature; the situations of his characters never fail to raise an interest in the reader, and often excite the tear of pity. His fables are celebrated; his charac-

ters are noble and well supported; his plots are excellently conducted, and happily unravelled. "There are scenes (says Voltaire) worthy of Corneille when he does not declaim, and of Racine when he is not feeble." His operas, in point of the pathetic, may be compared with our finest tragedies; and may be read with great pleasure, independent of the charms of the music. We must not, however, expect to find in Metastasio that exact regularity, and that fertile simplicity, which constitutes the excellence of some of our tragic poets: But though he sometimes transgresses the unities of time and place, he always preserves the unity of interest. Notwithstanding all these advantages, some critics will not allow him the merit of invention, which is the first qualification of a poet. They consider him only as a successful imitator of the French tragic writers, from whom a great part of his beauties are borrowed, and place him at the head of the finest wits of Italy, but deny that he possessed genius. He was a fond admirer of the ancients; and this admiration, increasing with the solidity of his understanding, continued to the last period of his life. He recommended reading them, as he himself had done, in a chronological order. His memory was excellent, and continued unimpaired even in old age. Horace was his favourite author, and he could repeat almost the whole of him. Metastasio, who, as we have observed, was the pupil of the celebrated Gravina, added a gentleness of character peculiar to himself to the accuracy of thinking and great erudition of his master. His abilities and fame were respected by the critics in general; and whereas the life of most men of letters is one continued warfare, his days happily glided away in tranquillity and peace. The circumstance which occasioned the change of his name is thus related in a late anecdote: "Gravina's barber, who, like most of his profession, was a great talker, one day informed him, that in the *Place de la Valicella*, where he had his shop, a young boy came every evening, and sung extempore verses of his own composition, so harmonious and elegant that all the passengers stopped to listen to them. Gravina, upon this information, added one to the number of the young poet's audience, and found the verses so superior to the idea which he had formed of them from the account of the barber, and so much above the capacity of a child of ten or eleven years of age, that he instantly determined to undertake the cultivation of so promising a plant. His first care was to put the young *Trapassi* (which was the boy's name) to school; but apprehending that the ordinary methods of education might check the progress of so uncommon talents, he took him home to his own house, and changed his name into *Metastasio*, which signifies the same thing in Greek. In short, by a plan of education and by instructions suited to his genius, Gravina laid the foundation of that reputation which he predicted, and which Metastasio now enjoys." *Vies des Hommes Illustres d'Italie*, Tom. I. p. 187.

METASTASIS, in medicine, a transposition or settlement of some humour or disease in some other part; and sometimes it signifies such an alteration of a disease as is succeeded by a solution.

METATARSUS (*μετα* beyond, and *ταρος* the tarsus), in anatomy, that part of the human skeleton containing

Metathesis, containing the middle of the foot. See ANATOMY, n° 70
Metelin.

METATHESIS, in grammar, a species of the metaplasmus; being a figure whereby the letters or syllables of a word are transposed, or shifted out of their usual situations, as *pistris* for *pristis*, *Lybia* for *Libya*, &c.

This word is, by physicians, used with respect to morbid causes, which, when they cannot be evacuated, are removed to places where they are less injurious.

METELIN, the modern name of the island of Lesbos. See LESBOS and MITYLENE.

In the Irish Philosophical Transactions for 1789, we have a description of this island by the earl of Charlemont, in which he speaks with raptures of its beauties. "The mountains, whose rugged tops exhibit a pleasing interspersion of rocks and fine groves, have their green sides, for many miles along the coast, covered with olives, whose less agreeable verdure is corrected, embellished, and brightened by a lively mixture of bays and laurels aspiring to the height of forest-trees, of myrtles and pomegranates, of arbutus rich at once in blossom and in berry, of mulberries growing wild and laden with fruit, &c. Winter is here unknown, the verdure is perpetual, and the frequency of evergreens gives to December the colour of June. The parching heat of summer is never felt; the thick shade of trees, and thousands of crystal springs which every where arise and form themselves into unnumbered rivulets, joined to the refreshing sea-breeze the constant corrective and companion of noon tide heat, qualify the burning air and render the year a never-ending May. The houses are constructed in such a manner as to have the best view of these natural beauties. Each is a square tower neatly built of hewn stone, so high as to overtop the trees, and to command a view of the sea and neighbouring islands. The lower stories are granaries and storehouses; and the habitable apartments are all at the top, to which you ascend by a stone stair, built for the most part on the outside, and surrounding the tower; so that from the apartment the trees are overlooked, and the whole country is seen, while the habitations themselves, which are very numerous, peering above the groves, add life and variety to the enchanting prospect, and give an air of human population to these woodlands, which might otherwise be supposed the region of Dryads, of Naiads, and of Satyrs."

The most remarkable thing, however, in this island is a custom by which the women have here openly usurped those rights of sovereignty which in other countries are supposed to belong essentially to the men. "Contrary (says his lordship) to the usage of all other countries, the eldest daughter here inherits; and the sons, like daughters every where else, are portioned off with small dowers, or, which is still worse, turned out penniless to seek their fortune. If a man has two daughters, the eldest, at her marriage, is intitled to all her mother's possessions, which are by far the greater part of the family estate, as the mother, keeping up her prerogative, never parts with the power over any portion of what she has brought into the family, until she is forced into it by the marriage of her daughter; and the father also is compelled to ruin himself by adding whatever he may have scraped

together by his industry. The second daughter inherits nothing, and is condemned to perpetual celibacy. She is styled a *calogria*, which signifies properly a religious woman or nun, and is in effect a menial servant to her sister, being employed by her in any office she may think fit to impose, frequently serving her as waiting-maid, as cook, and often in employments still more degrading. She wears a habit peculiar to her situation, which she can never change; a sort of monastick dress, coarse, and of a dark brown. One advantage, however, she enjoys over her sister, that whereas the elder, before marriage, is never allowed to go abroad, or to see any man, her nearest relations only excepted, the *calogria*, except when employed in domestic toil, is in this respect at perfect liberty. But when the sister is married, the situation of the poor *calogria* becomes desperate indeed, and is rendered still more humiliating by the comparison between her condition and that of her happy mistress. The married sister enjoys every sort of liberty; the whole family fortune is hers, and she spends it as she pleases; her husband is her obsequious servant, her father and mother are dependent upon her, she dresses in a most magnificent manner, covered all over, according to the fashion of the island, with pearls and with pieces of gold, which are commonly sequins; thus continually carrying about her the enviable marks of affluence and superiority, while the wretched *calogria* follows her as a servant, arrayed in simple homespun brown, and without the most distant hope of ever changing her condition. Such a disparity may seem intolerable, but what will not custom reconcile? Neither are the misfortunes of the family yet at an end. The father and mother, with what little is left them, contrive by their industry to accumulate a second little fortune; and this, if they should have a third daughter, they are obliged to give to her upon her marriage; and the fourth, if there should be one, becomes her *calogria*; and so on through all the daughters alternately. Whenever the daughter is marriageable, she can by custom compel the father to procure her a husband; and the mother, such is the power of habit, is foolish enough to join her in teasing him into an immediate compliance, though its consequences must be equally fatal and ruinous to both of them. From hence it happens, that nothing is more common than to see the old father and mother reduced to the utmost indigence, and even begging about the streets, while their unnatural daughters are in affluence; and we ourselves have frequently been shown the eldest daughter parading it through the town in the greatest splendor, while her mother and sister followed her as servants, and made a melancholy part of her attendant train.

"The sons, as soon as they are of an age to gain a livelihood, are turned out of the family, sometimes with a small present or portion, but more frequently without any thing to support them; and thus reduced, they either endeavour to live by their labour, or, which is more usual, go on board some trading vessel as sailors or as servants, remaining abroad till they have got together some competency, and then return home to marry and to be henpecked. Some few there are who, taking advantage of the Turkish law, break through this whimsical custom, who marry their *calogrias*, and

Metelin.

Metelin. retain to themselves a competent provision: but these are accounted men of a singular and even criminal disposition, and are hated and despised as conformists to Turkish manners, and deserters of their native customs; so that we may suppose they are few indeed who have the boldness to depart from the manners of their country, to adopt the customs of their detested masters, and to brave the contempt, the derision, and the hatred, of their neighbours and fellow-citizens.

"Of all these extraordinary particulars I was informed by the French consul, a man of sense and of indisputable veracity, who had resided in this island for several years, and who solemnly assured me that every circumstance was true: but indeed our own observation left us without the least room for doubt, and the singular appearance and deportment of the ladies fully evinced the truth of our friend's relation. In walking through the town, it is easy to perceive, from the whimsical manners of the female passengers, that the women, according to the vulgar phrase, *wear the breeches*. They frequently stopped us in the streets, examined our dress, interrogated us with a bold and manly air, laughed at our foreign garb and appearance; and showed so little attention to that decent modesty which is or ought to be the true characteristic of the sex, that there is every reason to suppose they would, in spite of their haughtiness, be the kindest ladies upon earth, if they were not strictly watched by the Turks, who are here very numerous, and would be ready to punish any transgression of their ungallant laws with arbitrary fines. But nature and native manners will often baffle the efforts even of tyranny. In all their customs these manly ladies seem to have changed sexes with the men. The woman rides astride, the man sits sideways upon the horse; nay, I have been assured that the husband's distinguishing appellation is his wife's family name. The women have town and country houses, in the management of which the husband never dares interfere. Their gardens, their servants, are all their own; and the husband, from every circumstance of his behaviour, appears to be no other than his wife's first domestic, perpetually bound to her service, and slave to her caprice. Hence it is that a tradition obtains in the country, that this island was formerly inhabited by Amazons; a tradition, however, founded upon no ancient history that I know of. Sappho indeed, the most renowned female that this island has ever produced, is said to have had manly inclinations; in which, as Lucian informs us, she did but conform with the singular manners of her countrywomen: but I do not find that the mode in which she chose to show these inclinations is imitated by the present female inhabitants, who seem perfectly content with the dear prerogative of absolute sway, without endeavouring in any other particular to change the course of nature; yet will this circumstance serve to show, that the women of Lesbos had always something peculiar, and even peculiarly masculine, in their manners and propensities. But be this as it may, it is certain that no country whatsoever can afford a more perfect idea of an Amazonian commonwealth, or better serve to render probable those ancient relations which our manners would induce us to esteem incredible, than this island of Metelin. These lordly ladies are for the most part very handsome in spite of their

dress, which is singular and disadvantageous. Down *Metelin.* to the girdle, which as in the old Grecian garb is raised far above what we usually call the waist, they wear nothing but a shift of thin and transparent gauze, red, green, or brown, through which every thing is visible, their breasts only excepted, which they cover with a sort of handkerchief; and this, as we were informed, the Turks have obliged them to wear, while they look upon it as an encumbrance, and as no inconsiderable portion of Turkish tyranny. Long sleeves of the same thin material perfectly show their arms even to the shoulder. Their principal ornaments are chains of pearl, to which they hang small pieces of gold coin. Their eyes are large and fine; and the nose, which we term Grecian, usually prevails among them, as it does indeed among the women of all these islands. Their complexions are naturally fine; but they spoil them by paint, of which they make abundant use; and they disfigure their pretty faces by shaving the hinder part of the eyebrow, and replacing it with a straight line of hair neatly applied with some sort of gum, the brow being thus continued in a straight and narrow line till it joins the hair on each side of their face. They are well made, of the middle size, and for the most part plump; but they are distinguished by nothing so much and so universally as by a haughty, disdainful, and supercilious air, with which they seem to look down upon all mankind as creatures of an inferior nature, born for their service, and doomed to be their slaves; neither does this peculiarity of countenance in any degree diminish their natural beauty, but rather adds to it that sort of bewitching attraction which the French call *piquant*."

His lordship has been at great pains to investigate the origin of such a singular custom; but is unable to find any other example in history than that of the Lycians, who called themselves by the names of their mothers, and not of their fathers. When asked by their neighbours who they were? they described themselves by their maternal genealogy. If a gentlewoman should marry a slave, the children by that marriage were accounted noble; but should the first man among them marry a foreign woman, the children would be accounted ignoble. This custom is mentioned by several ancient authors. A difficulty of no little magnitude occurs, however, in accounting for the derivation of the inhabitants of Lesbos from the Lycians. This is solved in the following manner: In times of the most remote antiquity, the island of Lesbos was peopled by the Pelasgi, who, under their leader Xanthus, the son of Triopas king of Argos, first inhabited Lesbos: previous to that time they had dwelt in a certain part of Lycia which they had conquered; and in this country we may suppose they had learned the custom in question. But though this might readily be granted, as we know so little of the origin of ancient nations, yet the question still recurs, Whence did it originate among the Lycians? Here we are still more difficulted than before; and the only thing we have to help us out is an obscure tradition concerning Bellerophon, *viz.* that the hero having destroyed a boar which wasted the territory of Xanthus a city of Lycia, the inhabitants were so ungrateful as to return him no thanks for so great a favour; upon which, by his prayers, he caused the curse of barrenness to fall upon them, but was at length

Metelin,
Metellus

length prevailed upon, by the intreaties of the women, to intercede with his patron Neptune to pardon them. On this account it was decreed, that the people of Xanthus should be called by the names of their mothers and not of their fathers. Plutarch relates also, that Bellerophon not only freed the Lycians from an invasion of pirates, but from the Amazons also, whom he drove out of their country; "so that there may be some reason (says his Lordship) to suppose, that the Lycian women, by an intercourse with the Amazons, who had, it should seem, dwelt among them, were already previously prepared for the introduction of those customs, which were finally established in consequence of their patriotic merit in deprecating the wrath of Bellerophon, and in averting its fatal consequences."

This is the substance of what his Lordship advances to the origin of this extraordinary custom. He owns, that the traces are very obscure; and though he is conscious that such a speculation may be liable to ridicule, and he is aware "of some objections not easy to be answered, the coincidence will notwithstanding be allowed to be curious and very remarkable. The well known pertinacious adherence to ancient manners among the eastern nations, may in some measure excuse our credulity; and we may still add to our authority, by supposing that this same Xanthus may probably have given his name to the Lycian city of that denomination; and consequently must have inhabited that very part of Lycia where, according to Plutarch, he is supposed more immediately to have flourished."

METELLUS, the surname of the family of the Cæcili at Rome, the most known of whom were — A general who defeated the Achæans, took Thebes, and invaded Macedonia, &c.—Q. Cæcilius, who rendered himself illustrious by his successes against Jugurtha the Numidian king, from which he was surnamed *Numidicus*.—Another who saved from the flames the palladium, when Vesta's temple was on fire. He was then high-priest. He lost his sight and one of his arms in the action; and the senate, to reward his zeal and piety, permitted him always to be drawn to the senate-house in a chariot, an honour which no one had ever before enjoyed. He also gained a great victory over the Carthaginians, &c.—Q. Cæcilius Celer, another who distinguished himself by his spirited exertions against Catiline. He married the sister of Clodius, who disgraced him by her incontinence and lasciviousness. He died 57 years before Christ. He was greatly lamented by Cicero, who shed tears at the loss of one of his most faithful and valuable friends.—L. Cæcilius, a tribune in the civil wars of J. Cæsar and Pompey. He favoured the cause of Pompey, and opposed Cæsar when he entered Rome with a victorious army. He refused to open the gates of Saturn's temple, in which were deposited great treasures; upon which they were broke open by Cæsar, and Metellus retired when threatened with death.—Q. Cæcilius, a warlike general who conquered Crete and Macedonia, and was surnamed *Macedonicus*. He had four sons, of which three were consuls, and the other obtained a triumph, all during their father's lifetime.—A general of the Roman armies against the Sicilians and Carthaginians. Before he marched, he

offered sacrifices to all the gods except Vesta; for which neglect the goddess was so incensed, that she demanded the blood of his daughter Metella. When Metella was going to be immolated, the goddess placed a heifer in her place, and carried her to a temple at Lanuvium, of which she became the priestess.—Another, surnamed *Dalmaticus* from his conquest over Dalmatia, A. U. C. 634.—Cimber, one of the conspirators against J. Cæsar. It was he who gave the signal to attack and murder the dictator in the senate-house.—Pius, a general in Spain, against Sertorius, on whose head he set a price of 100 talents and 20,000 acres of land.

METEMPSYCHOSIS, (formed of *μετα* "beyond," and *ψυχη* "I animate or enliven"), in the ancient philosophy, the passage or transmigration of the soul of a man, after death, into the body of some other animal.

Pythagoras and his followers held, that after death mens souls passed into other bodies, of this or that kind, according to the manner of life they had led. If they had been vicious, they were imprisoned in the bodies of miserable beasts, there to do penance for several ages; at the expiration whereof, they returned afresh to animate men. But, if they lived virtuously, some happier brute, or even a human creature, was to be their lot.

What led Pythagoras into this opinion was, the persuasion he had that the soul was not of a perishable nature: whence he concluded that it must remove into some other body upon its abandoning this. Lucan treats this doctrine as a kind of officious lie, contrived to mitigate the apprehension of death, by persuading men that they only changed their lodging, and only ceased to live to begin a new life.

Reuchlin denies this doctrine; and maintains that the metempsychosis of Pythagoras implied nothing more than a similitude of manners, desires, and studies, formerly existing in some person deceased, and now revived in another alive. Thus when it was said that Euphorbus was revived in Pythagoras, no more was meant than that the martial virtue which had shone in Euphorbus at the time of the Trojan war, was now, in some measure, revived in Pythagoras, by reason of the great respect he bore the *athleta*. For those people wondering how a philosopher should be so much taken with men of the sword, he palliated the matter, by saying, that the soul of Euphorbus, *i. e.* his genius, disposition, and inclinations, were revived in him. And this gave occasion to the report, that Euphorbus's soul, who perished in the Trojan war, had transmigrated into Pythagoras.

Ficinus asserts, that what Plato speaks of the migration of a human soul into a brute, is intended allegorically, and is to be understood only of the manners, affections, and habits, degenerated into a beastly nature by vice. Serranus, though he allows some force to this interpretation, yet inclines rather to understand the metempsychosis of a resurrection.

Pythagoras is said to have borrowed the notion of a metempsychosis from the Egyptians; others say, from the ancient Brachmans. It is still retained among the Banians and other idolaters of India and China; and makes the principal foundation of their religion. So extremely are they bigotted to it, that they not only

forbear

Metempts-
fis.

forbear eating any thing that has life, but many of them even refuse to defend themselves from wild beasts. They burn no wood, lest some little animalcule should be in it; and are so very charitable, that they will redeem from the hands of strangers any animals that they find ready to be killed. See PYTHAGOREANS.

METEMPTOSIS (from *μετα* "post," and *πτω* *cado* "I fall,") a term in chronology, expressing the solar equation, necessary to prevent the new moon from happening a day too late. By which it stands contradistinguished from *proemptosis*, which signifies the lunar equation, necessary to prevent the new moon from happening a day too soon.

The new moons running a little backwards, that is, coming a day too soon at the end of 312 years and a half; by the *proemptosis*, a day is added every 300 years, and another every 2400 years: on the other hand, by the *metemptsosis*, a bissextile is suppressed each 134 years; that is, three times in 400 years. These alterations are never made but at the end of each century; that period being very remarkable, and rendering the practice of the calendar easy.

There are three rules for making this addition or suppression of the bissextile-day, and, by consequence, for changing the index of the *epacts*. 1. When there is a *metemptsosis* without a *proemptosis*, the next following, or lower index, must be taken. 2. When there is a *proemptosis* without a *metemptsosis*, the next preceding or superior index is to be taken. 3. When there are both a *metemptsosis* and a *proemptosis*,

or when there is neither the one nor the other, the same index is preserved. Thus, in 1600, we had D: in 1700, by reason of the *metemptsosis*, C was taken: in 1800, there will be both a *proemptosis* and a *metemptsosis*; so the same index will be retained. In 1900, there will be a *metemptsosis* again, when B will be taken; which will be preserved in 2000, because there will then be neither the one nor the other. This is as far as we need compute for it: but Clavius has calculated a cycle of 301800 years; at the end of which period, the same indices return in the same order. See EPACT.

METEOR, (by the Greeks called *μετεωρα*, q. d. *sublimata* or "high raised;" by the Latins *impressiones*, as making signs or impressions in the air), commonly denotes any bodies in the air that are of a flux or transitory nature. Hence it is extended to the phenomena of hail, rain, snow, thunder, &c.; but is most commonly confined to those unusual and fiery appearances named *falling-stars*, *ignes fatui*, *aurora boreales*, &c. whether they appear at a great distance from the earth or not. See METEOROLOGY.

METEOROLOGICAL, something belonging to meteors.

METEOROLOGICAL Journal, is a table recording the daily state of the air, exhibited by the barometer, thermometer, hygrometer, anemometer, and other meteorological instruments. We have many journals of this kind, kept at the house of the Royal Society, and by different observers in other places, in the Philosophical Transactions, the Memoirs of the Academy of Sciences, and similar publications.

Meteor,
Meteorolo-
gical.

M E T E O R O L O G Y;

THAT science which investigates the phenomena of our atmosphere* (commonly called *meteors*), giving an account of the circumstances attending each, and explaining the causes from whence they arise.

In considering this science, we find the objects of it naturally divided into two classes, viz. those which rise high in the heavens, seemingly without any connection with this earth; and others which are more particularly connected with the earth, or are perceptible only in the lower regions of the atmosphere. The former, which may properly be called *celestial meteors*, are only three in number, viz. the large fire-balls, falling stars, and *aurora borealis*. The second class is much more numerous; including the phenomena of the ordinary winds, rain, hail, snow, clouds and vapours of all kinds, thunder and lightning, hurricanes, whirlwinds, water-spouts, *ignes fatui*, and other wandering luminous appearances; not excepting the various changes of the atmosphere itself, with regard to its specific gravity, rarefaction, heat, and moisture, as indicated by the barometer, thermometer, and hygrometer.

To treat of all these in a satisfactory manner, it is plain that we ought to have an intimate acquaintance with the constitution of the atmosphere; with the nature of those powerful agents by which it appears to be principally influenced, viz. fire, light, and electric fluid; and with their peculiar modes of operation and action upon one another and upon the atmosphere, and this in

every possible variety of circumstances. Nor is even all this sufficient: The various phenomena of rain, wind, snow, thunder, heat, cold, &c. are known to depend very much upon the situation of different places on the surface of the earth; and their occasional variations are with great reason *suspected* to proceed, partly at least, from changes which take place in the bowels of the earth*: whence a meteorologist ought not only to be perfectly well acquainted with geography, but with mineralogy also; and that to an extent at which human knowledge will probably never arrive.

In a science so very difficult, it is not to be supposed that any thing like a certain and established theory can be laid down: our utmost knowledge in this respect goes no farther as yet than to the establishment of a few facts; and in reasoning even from these, we are involved every moment in questions which seem scarcely within the compass of human wisdom to resolve.

In considering the subject of meteorology, it will readily be admitted, that the whole atmospherical phenomena depend some how or other upon the action of the sun upon the earth, and the annual and diurnal revolutions of the latter. As these causes, however, are always invariably the same, why do we not find the same regularity in meteors that we do in other phenomena of nature? The eclipses of the sun and moon, for instance, which depend on the different positions

Causes pro-
bably con-
cerned.

* See At-
mosphere.

1
Meteors,
how di-
vided.

2
Difficulties
attending
the subject.

sitions of the earth and moon with regard to the great luminary, are found to follow a certain and regular course; so that the very same eclipses, both as to quantity and duration, which happened before will happen again. But with meteors the case is quite different. Most of the atmospherical phenomena are so various and uncertain, that no person can pretend to reduce them to any kind of rule. Every succeeding year, for instance, differs in a vast number of particulars from that which preceded it, even in such as are the most similar to one another. Sometimes we find a number of years successively similar to one another, and another set quite different taking place immediately after them; and some have even fancied that this succession took place every 19 years, nearly the time of the revolution of the moon's nodes, though the observations on which this opinion is built are far from being sufficient to establish it: at any rate, the dissimilarity between the phenomena of different years may sufficiently warrant us to conclude, that other causes besides the regular action of the sun and revolution of the earth are concerned. Some of these causes may be supposed to be fermentations and other commotions within the bowels of the earth itself; but as all fermentation is a regular process, and takes place only in certain circumstances, of which heat is a very considerable one, why is there not annually a certain quantity of this fermentation excited, and why are not regular effects observed in proportion? It does not indeed appear, that the immense variety which occurs in meteorological appearances can by any means be accounted for but by the interference of some causes in their own nature *irregular*; that is, capable of such endless variety, that no assignable space of time is sufficient to exhaust it. These causes, as they cannot be proved to exist either on the surface of the earth or in its internal parts, must be sought for in the celestial expanse itself. Sir Isaac Newton supposed the planets to be influenced by the comets, and that from the tails of the latter some of the finer parts of our atmosphere were produced. He even supposed, that from these bodies a quantity of water, imagined to be wasted in the various operations of nature, might be supplied. But if it is not unreasonable to suppose that *comets* answer some such purposes in nature, it is as little unreasonable to think that the *planets* may influence the atmospheres of one another. That this must be the case indeed is very probable, not only on account of the light they reflect upon one another, but also by reason of their spheres of mutual attraction, which extend an immense way, and are so powerful in the planets Jupiter and Saturn, that they disturb the motions of each others satellites as they pass. But besides even these causes, if we allow them to be such, there are others which take place in the immense void betwixt the celestial bodies, and which has with great impropriety been determined an absolute vacuum. That changes do take place in this space, is evident from what is related of the temporary disappearance of some of the satellites of Saturn, and their sudden re-appearance, without any perceptible change in our atmosphere so as to affect our view of other celestial objects. It may appear ridiculous to think, that a change in such distant regions should have any influence upon

the atmosphere of the earth; but we must remember, that if the universe is connected together as one vast system, which we have every reason to believe; it is as impossible that a change can take place in any part without affecting the whole in some degree, as it is impossible to change any part of a clock or watch without in some measure affecting the whole movement.

But of all the changes which take place in the celestial regions, those which affect the sun seem most likely to produce changes in our atmosphere, and to be the hidden cause of many meteorological phenomena. That the sun is not exempt from those changes, is evident from the spots which are always or for the most part to be seen on his disk when viewed through a telescope. It has been observed in some years, that the sun has seemed to lose his influence, and even to the naked eye appeared much dimmer than usual. In such cases it is impossible but our atmosphere, and even the whole solar system, must have been affected; and not only must the seasons for the present time have felt the malign influence of those spots, but the atmosphere itself may have acquired such a disposition as to produce seasons of a peculiar nature for a number of years afterwards. If it be true, according to the hypothesis of some, that the sun is supplied with fuel by comets falling into his body, it is plain that every new accession of this kind must have a proportionable effect upon all the bodies exposed to his light. If the comets do not perform any such office, still it is very probable that they answer some purposes to the planets, because they are never seen without the planetary regions: and though their influence be not immediately perceptible, it is impossible to prove that they have none, nor indeed is it probable that they have not; for we are very certain, that the influence of any object extends as far as its light, and how much farther we cannot tell. Considering the matter in this view, therefore, there is not a spot which can obscure the sun, a comet that can appear in the celestial regions, a planet that can approach the earth, nor perhaps a belt or spot which can take place on Mars, Jupiter, or Saturn, which may not be productive of important changes in our atmosphere, and affect the meteors produced by it in many different ways.

It would no doubt be an error to have recourse to so many obscure causes, were there any plain and obvious ones from whence the phenomena could be deduced. But the endless variety of meteors which occur throughout every part of the globe, plainly show that the causes, whatever they are, must be infinitely varied also. The principal one is no doubt the action of the sun upon the earth and atmosphere in its various positions: but this is regular; and, did nothing else interfere, would produce regular effects. Secondary causes probably are the action of the moon and planets: but these also are regular, though much more diversified than the former: so that we are at last obliged to have recourse to causes still more obscure and remote, as comets, spots on the sun, and changes taking place in the ethereal fluid which pervades the whole celestial expanse. These we must either assign as the remote causes of the phenomena of our atmosphere,

Or in the sun.

6. Action of the sun, moon, and planets, concerned.

4 Some of them probably exist in the celestial expanse;

isphere, or admit others equally obscure; or we must be contented to own our ignorance, as indeed must at all events be frequently the case.

But though, to satisfy ourselves, such conjectures may occasionally be indulged, it is not from them that we are to derive any of the regular phenomena of nature; for these are evidently owing to the settled and established action of heat, light, and electric matter, which have already been enumerated as the great powers influencing, and indeed in a great measure forming, the substance of our atmosphere. The most remarkable effects of these are,

7
Evaporation a principal cause of meteors,

8
Natural evaporation different from artificial.

9
Dryness of the upper regions of the atmosphere.

10
Surprising instances of this dryness.

11
Water sometimes changes its nature.

I. *Evaporation.* This, which is the principal cause of almost all the meteors of our atmosphere, may be reckoned in a more particular manner the effect of heat. Upon this principle it is explained under the article CHEMISTRY, where vapour is shown to be a compound of water and fire; and such it is supposed to be by M. de Luc, in his Treatise on Meteorology, as well as by other philosophers of the highest rank. In considering this operation, however, as carried on by nature, we will soon find, that it proceeds in a manner very different from what takes place in our chemical operations. In the latter, evaporation is merely the effect of heat; and the process cannot go on without a considerable degree of it, especially if the vessel containing the fluid be close. In the natural way, on the contrary, the process goes on under almost every degree of cold we know; the vapours ascend to an height which has never yet been determined; and, from the extreme cold which they sustain, show evidently that they are connected with our atmosphere by means of some other agent besides heat. From the continual ascent of vapour indeed, if the operations of nature were of the same kind with those of art, the upper parts of our atmosphere would be always involved in a fog, by reason of the condensation of the vast quantity which continually ascends thither; but so far is this from being the case, that in those elevated regions to which the vapours continually ascend, the air is much drier than at the surface of the ground. This was experienced by M. de Saussure and M. de Luc in their journeys up the Alps. The air was there found to be excessively dry, and evaporation to go on much more rapidly than below; so that the surface of their bodies was parched up, and an excessive thirst took place by reason of the great absorption of the moisture. The same dryness was manifest by the hygrometer, which could scarce ever be brought to indicate any moisture, even when our travellers were surrounded with clouds, hail, and rain. From many experiments, indeed, it is evident, that water, after being reduced into a state of vapour, is capable of undergoing a certain change, by which it lays aside its fluidity entirely, and even to appearance its specific gravity; so that it becomes, as far as we can judge, a substance totally different from what it was before. This may be understood from the common operation of slacking lime; for in that case, the water unites with the lime so intimately, that the whole assumes the form of a dry powder, extremely greedy of moisture, and which cannot be reduced to its former state of quicklime without undergoing a much greater degree of heat than the water

N^o 216.

by itself could bear. The same thing is manifest from mixing dry plaster of Paris with water; for thus a vast quantity of the water is fixed, and becomes in a manner solid. A still more remarkable instance is in sending the steam of water over red-hot iron; for there the fluid unites in such a manner with the metal, that it cannot be expelled from it even by the heat of a burning-glass. Other instances are mentioned under the article WATER; here we are to consider the changes which the element undergoes after being reduced to the state of vapour. The first of these is, its assuming the appearance of smoke or fog when mixed with the common atmosphere; which smoke, when examined by a microscope, appears to be composed of an infinite number of spherules of water, hollow, and filled with a fluid specifically lighter than air, by which means they ascend in it. As long as the aqueous vapour retains this visible form, it retains also its humidity, and will again become a liquid, and wet whatever comes in its way; and this the more readily, while it retains any sensible degree of heat. As the vapour cools in the atmosphere, it gradually assumes an aerial state, mixing itself with the air so as to be no longer distinguishable from it. In this state the air itself does not by any means appear to become more moist, but continually drier the more water it receives. This, however paradoxical it may seem, is a certain fact: for in summer, though we are assured that evaporation goes on very rapidly from the surface both of the sea and land, yet the air, so far from being moist, is much drier than at any other time; and yet we know that the whole quantity evaporated is some how or other received by the atmosphere. After the water has attained to this state, our inquiries concerning it must in a great measure stop. We know not now, whether it has the form of small hollow spherules, or whether it really becomes part of the atmosphere itself, and assumes the form of what we call *dephlogisticated air*. From some experiments in which that kind of air is produced from water, we are certain, that part of this element is converted into air; but in these operations, the evaporation of the water is prevented by being carried on in close vessels; so that we cannot tell whether that which would be mere steam in the open air, becomes dephlogisticated air in close vessels or not. From the immense waste of dephlogisticated air, indeed, and the vast quantity which always surrounds the earth, we may suspect that the water, after undergoing the natural process of evaporation, does really become changed into this aerial fluid; and thus we will have a more ample source of it than can be derived from vegetation, or any other cause with which we are yet acquainted.

On this subject M. de Luc has some very curious observations, built principally upon the new doctrine of the composition of water; which, though a position maintained by the antiphlogistians, is by no means inconsistent with the existence of phlogiston, but rather a proof of it. Our author first began to alter his sentiments concerning the aqueous existence of vapour in the atmosphere, from the circumstance already mentioned concerning the great dryness of the upper atmospherical regions already taken notice of.

A

12
Particular account of natural evaporation.

13
Is capable of being decomposed.

14
Observations of M. de Luc.

A very remarkable instance of this was, that the felle of his cane dropped off during his journey up one of the Alpine mountains, which he never had observed it to do before. It is observed likewise, that the air in these elevated regions is somewhat drier in the night than in the day-time; for which M. de Luc gives the following reason, viz. that the air on the plains being condensed by the cold, the superior air must subside, and the air on the mountains of course be replaced by the drier air from above them; though he thinks that this dryness may also be imputed in part to some other cause. This increase of dryness in the night, however, seems less constant than that in the day-time. Our author has often arrived at the tops of mountains before sun-rise, and sometimes found the grass covered with dew; though he never had the good fortune to be able to determine the state of the air for want of an hygrometer: nor indeed could the appearance of dew be any certain indication of the state of the atmosphere, there being strong reasons to believe, that dew is occasioned in great measure by vegetables themselves; for grass, when covered with glass plates, was found to become moist as well as that which had been exposed to the open air. In this case, the plates became moist both on the upper and under sides; but when suspended a foot above the ground, they were found to be covered with dew only on the upper part.

15
M. Saussure's method of accounting for the dryness of the air.

The dryness of the air on the tops of high mountains was otherwise accounted for by M. Saussure.—When on Mount Blanc, at the height of 7200 feet above the level of the sea, he found, that from six in the evening till half past five next morning, his hygrometer moved 21 degrees (the whole scale containing 100) towards dryness. But this he accounts for by saying, that from sunrise to three or four in the afternoon, the quantity of vapours in the neighbourhood of the earth is continually diminishing, because they ascend in the atmosphere, either in virtue of their own levity, or by means of a vertical wind, which he supposes to be produced by the heat of the sun; that, from the time just mentioned till next morning, their quantity increases in the lower strata, because the upper vapours re-descend in proportion as they condense; and that in the higher regions of the atmosphere, the reverse ought to be the case, as the upper strata are then left drier by the previous descent of the vapours. This argument, however, is contradicted by M. Saussure himself in another part of his work; where he says, that in the middle of the day, when the sun is hottest, the air in the neighbourhood of the earth contains really more water than it does at the moment when a refreshing dew falls. It is besides impossible that a vertical wind can ever be occasioned by the heat of the sun; for this produces only a general expansion of the whole body of the atmosphere, as a condensation of it is occasioned by the action of cold: neither could any considerable quantity of vapour (supposing with M. Saussure that it is a chemical solution of water in air) descend in the night-time; for, according to him, this compound differs very little from common air in its capacity of being expanded and condensed. Neither, according to M. Saussure himself, can any part of the water

16
Insufficient.

with which the air is combined descend at all, until some portion of the former becomes supersaturated with it, that is, till it has received more than it can hold in solution. But if this should happen to be the case, the superfluous quantity would then appear in the form of a mist or cloud, and the hygrometer would indicate extreme humidity; whereas the contrary indication constitutes the difficulty.

It is besides evident, from innumerable instances, that mere cold will not by any means occasion the condensation of aerial vapour. A most remarkable example of this is given by M. de Luc, in an account of a storm in which he was involved on one of the Alps. "Though the hygrometer (says he) was within $33\frac{1}{2}$ degrees of extreme dryness, or $66\frac{1}{2}$ from extreme humidity, thick clouds formed around us, which obliged us to think of retreating: in a little time the summit of the mountain was surrounded by them: they spread and covered the whole horizon: a premature night surprised us in a very dangerous road; and we suffered one of the most violent tempests I ever experienced, of wind, rain, hail, and thunder. The storm lasted great part of the night, and extended all over the neighbouring mountains and plains; and after it had ceased, the rain continued, with only a few intermissions, till next day at noon. In one of these intervals, I examined the hygrometer on the outside of our cabin; it showed only $1^{\circ}\frac{6}{10}$ more humidity than before; and even this increase was no more than what the difference of heat was capable of producing. Nevertheless, new clouds continually rolled around us; and the rain, which presently began again, accompanied us as it were by fits to the bottom of the mountain. When arrived there, we saw the clouds disperse entirely. I observed the hygrometer again in the open air; and though the earth was all drenched with water, and the heat of the sun much less, the hygrometer was $1^{\circ}\frac{7}{10}$ drier than it had been two days before, after a course of fine weather. Where was all this water, and all the ingredients of the storm, while the hygrometer showed such a degree of dryness in the very stratum where it was formed?"

17
Aerial vapour cannot be condensed by cold.

M. de Luc adopts the opinion concerning vapour which has been published in this work, under the articles CHEMISTRY, EVAPORATION, and many others, viz. that it is a combination of fire with water. By vapour, however, he does not mean the visible steam issuing from heated liquids, but that invisible and subtle fluid which is found to be formed even *in vacuo*, and which of consequence disproves the hypothesis of those who hold that vapour is a solution of water in air. Our author, however, gives a solution of the difference betwixt what he calls fog or mist and vapour, which seems not founded upon any evident principle. According to him, this vapour cannot subsist unless the particles of water united to the fire be at a certain distance from one another. When this distance is lessened, a decomposition takes place by reason of the attraction of the aqueous particles to one another; and they then appear in their proper form of a liquid, the fire dissipating itself through the atmosphere. The smallest distance to which the particles can be brought without any decomposition,

18
M. de Luc's definition of vapour.

varies according to the temperature; but is always constant in the same degree. When the thermometer stands at temperate, or thereabouts, watery vapours, compressed into the smallest space they can bear, are found to have between $\frac{1}{10}$ th and $\frac{1}{15}$ th of the elasticity of air; but have less than $\frac{1}{15}$ th of its weight. If such vapour, however, be mixed with air, the minimum distance is greatly increased, by reason of the interposition of aerial particles; and thus it can subsist under a much greater pressure than it could otherwise endure. In the heat of boiling water they can, without any mixture of air, bear the pressure of the atmosphere: for ebullition, under any given pressure, cannot take place until the vapour produced in the liquor has acquired a degree of expansive force sufficient to raise the liquor into bubbles under that pressure; and as long as the vapour retains this heat, it must continue capable of resisting the same pressure. As the heat abates, a decomposition begins; hence the opaque steam over boiling water, which, by becoming vapour again by uniting with the fire it meets with in a larger space, is diffused by its expansibility. Thus, vapours are continually undergoing decompositions and new vaporifications. This evaporation of the clouds after they were once formed, M. de Luc observed very evidently; some parts being continually detached, and gradually diminishing and disappearing, while new ones are formed; so that the clouds do not continue the same for two moments together; and the evaporation goes on so fast, that a cloud could not subsist without constant and large supplies.—These phenomena appear to be independent of heat and cold: for sometimes clouds form suddenly in the middle of a hot day; and after they have poured down their water, all is clear again: and sometimes they evaporate after sunset, gradually vanishing in the calmest weather without any change of place.—The appearances are such as would be produced by a large mass of water in violent ebullition, suspended invisibly in the atmosphere; and the similarity of effect naturally points out an analogy in the cause; that is, a source of vapour in the atmosphere itself. It is only when the vapour is produced too abundantly and too rapidly to be dispersed by evaporation that rain is formed; the vesicles in this case running together, and the water falling to the lower part, as it does in soap-bubbles, till they become thin enough to burst.

19
Evapora-
tion of the
clouds.

20
Remarks
on M. De
Luc's ob-
servations.

With regard to this explanation, however, though it may account for the artificial production and decomposition of vapour, it does not seem to answer for that produced in the natural way. That the latter is certainly in a state of dryness, cannot be denied; but it cannot be proved that ever any artificial steam is so, let the heat be what it will. Though the approach of the aqueous particles to one another, therefore, by a diminution of temperature, may occasion the decomposition of artificial steam, it does not seem to be so in the natural way; nor is there any source from which we can reasonably infer a very great and sudden accession of vapour from the earth to the upper regions of the atmosphere in particular places, which might increase the proximity of the aqueous particles, and thus bring on rain according to M. de Luc's hypothesis. It must likewise be remembered,

that, according to the doctrine upon which M. de Luc founds his system, water, when decomposed, is not converted into one species of air, but into two, viz. the dephlogisticated and inflammable, each of which contains a quantity of undecomposed water; so that there is still some ambiguity in the experiments; and as the two shrink up into very little bulk by their union, there should seem to be danger of producing vacuums of immense extent by the sudden union of the two airs in the high atmospherical regions.—These vacuums, were they to extend over the whole space occupied by a large cloud, might occasion dreadful concussions by the rushing in of the air to supply them: or even if we suppose them to be dispersed interstitially, they must certainly affect the barometer very greatly; which does not appear to be the case. M. Saussure, who passed several nights on one of the Alps, at the height of 10,578 feet above the level of the sea, does not mention any considerable variation of the barometer, though he was frequently involved, during that time, in the most violent storms of hail, wind, snow, thunder, and lightning. In the warm climates also, where we should think that the vast deluges of rain would often sink the barometer to an amazing degree, yet we seldom hear of any remarkable variation. M. de Prielong, in his account of Meteorological Observations made at Goree in 1787, informs us, that there were 16 or 18 hurricanes; and that the greater part of these raised the barometer from one twelfth to a sixth part of an inch; others sunk it as much, and some did not at all affect it. Another cause must therefore be concerned, which diminishes the rarefaction, or condenses the air as fast, or nearly so, as the condensation of the vapour would rarefy it: and that another cause really is concerned, we learn from M. Reynier, who has made a great number of observations upon the vapours formed on the Alps, and gives us the following account. “In the morning, the vapours condensed by the coldness of the night rise along the mountains in proportion as the sun rises above the horizon.—When the weather will be fine, they glide uniformly on the brink of the mountain, and rise over it by a regular motion, somewhat slow. When rain impends, the motion is irregular: they are alternately attracted and repelled by the mountain, and rise like elastic bodies rebounding. In a stormy season, particularly when there will be hail, the motions are still more rapid and irregular.” “This observation (add the Monthly Reviewers, from whom the above quotation was taken) may be confirmed in the mountainous countries of Great Britain; we have seen it among the mountains of Cumberland, particularly in the neighbourhood of Keswick. M. Reynier observes, and the observation is sufficiently near the surface not to be overlooked, that the appearance is electrical.”

21
M. Rey-
nier's ob-
servations.

Before we proceed to give any solution of the decomposition of vapour, it will be necessary to consider a little farther the nature of that fluid or fluids into which water is converted when it assumes a dry state in the atmosphere. In the experiments of Lavoisier and others, it seems with great probability to be reduced into the two different kinds of air already mentioned; but M. de Luc does not think that the at-
mosphere

22
Considera-
tions on the
nature of
the fluid in-
to which
water is
reduced by
evapora-
tion.

mosphere naturally contains any such fluids. Air, when artificially decomposed, does not contain inflammable, but phlogisticated or mephitic, air, mixed in a certain proportion with the dephlogisticated kind. These have different specific gravities; and our author is of opinion, that two fluids of this kind could not mingle uniformly with one another without separating through time; and as the dephlogisticated air has the greatest specific gravity, it thence follows, that the under parts of the atmosphere ought to be almost entirely composed of that kind, and the upper strata of the mephitic or inflammable kind. But this does not appear to be the case; so that M. de Luc concludes, that air is an homogeneous fluid, every particle being similar to every other, and consisting of all the ingredients that we extract from the mass, together, probably, with others yet unknown to us. Though a mixture of vital and mephitic air produces many of the effects of atmospheric air, we cannot thence conclude their absolute identity: the one may suffer a decomposition in order to the production of these effects, while the other produces them immediately. The mixture may support life for a time, but will it equally maintain health also? Though mephitic air by the mixture of one-third of vital air is prevented from being immediately fatal, we are not authorised to conclude that it is altogether innocent. On the whole then, if it is not in the immediate product of evaporation that rain has its source; if the vapours change their nature in the atmosphere, so as to be no longer sensible to the hygrometer or to the eye; if they do not become vapour again till clouds appear; and if, when the clouds are formed, no alteration is observed in the quality of the air; we must acknowledge it to be very probable, that the intermediate state of vapour is no other than air; and that the clouds do not proceed from any distinct fluid in the atmosphere, but from a decomposition of a part of the air itself, perfectly similar to the rest."

This opinion of M. de Luc appears the more probable, that the two ingredients into which water is artificially resolved, by the late experiments do not by any means re-compose atmospherical air by simple mixture; for these explode with extreme violence on the application of flame: the common atmosphere, also, when decomposed, does not resolve itself into dephlogisticated and inflammable air, but into the former, and what is called phlogisticated or the mephitic kind, the difference of which in specific gravity is much less than between dephlogisticated and inflammable airs, though it is probable that even these are connected either by means of a chemical union, or by some other ingredient we do not yet know. By this union the qualities of both may be in some measure changed, and a third kind of substance formed, as neutral salts may be made out of acids and alkalies. This third substance, which we call the common atmosphere, is proper for preserving both animal and vegetable life, which neither of the two ingredients are capable of doing; for plants wither and die in dephlogisticated air, and animals are suffocated in a moment by the mephitic kind; nor, indeed, do we know whether the dephlogisticated kind be altogether proper for the sustenance of animal life for any considerable length of time. It certainly will sustain it much longer than an equal quantity

of atmospherical air, even the purest we are acquainted with; but it is equally certain that animals confined in it die much sooner than according to its apparent purity they ought to do. It is not an unreasonable hypothesis, therefore, that though water may be artificially separated into the two fluids called dephlogisticated and inflammable airs, yet in the natural way the decomposition does not proceed beyond a certain point, which we may, in a subject of such an obscure nature, call a *chemical union*, or a state in which the two ingredients exist, and are capable of being separated when the air comes into contact with certain substances. Hence, when the atmosphere is taken into the lungs of an animal, some of the dephlogisticated part may enter the blood, and the phlogisticated part combining more intimately with the rest, may form fixed air or part of it appear in its proper form. In like manner, when the common atmosphere comes in contact with a vegetable, it is possible that the phlogisticated part may be absorbed by it, and the dephlogisticated part set free, which in the atmosphere may form new combinations, &c.

Granting this to be the case, and we can scarcely hope for a more probable conjecture on the subject, the decomposition of the vapour will be easily accounted for. If by any natural process the water can be converted into air, and if the latter is only water partially decomposed; then, by an inversion of the process, air may be instantly re-converted into water, and will become visible in fog or mist, or be condensed into rain, consisting of greater or smaller drops, according to the degree to which this inverted process is carried. With regard to the means used by nature for carrying on these two opposite processes, we can say very little; because the agents concerned in them are entirely beyond the reach of our senses. From M. Raynier's observation, indeed, of the clouds being attracted by the hills, it would seem probable that electricity was ultimately concerned, but in what manner we cannot determine. On this hypothesis, however, we may explain the phenomenon taken notice of by M. de Luc and others, viz. that even during the time of excessive rains the hygrometer showed scarce any signs of moisture, and that the clouds were in a constant state of evaporation or dissolution in the air. The hygrometer, we know, cannot show signs of moisture, unless it absorbs it; and it cannot absorb, unless the air around it really contains more vapour in an aqueous form than the hygrometer itself does. But in very elevated regions this can scarce ever be the case. So much of the pressure of the atmosphere is then taken off, that the water contained in any substance resolves itself into vapour with the utmost facility. Hence bodies brought from the lower regions into the higher will undoubtedly part with a great deal of the moisture they contained in the lower parts of the atmosphere, and which was kept in it by the superior pressure of the atmosphere in these parts. For the same reason, though the air in the upper regions should be made ever so moist, a body such as the hygrometer can never absorb so much as it would otherwise do, because the water in these regions has a natural tendency to fly away from it. It appears, however, that there was in reality *some* variation of the hygrometer, though small; and had it been possible to construct

23
Air and
water con-
vertible in-
to each
other.

fruct an hygrometer of materials found on the top of the mountain, which might be said to be naturalized to the climate, the scale of variation might probably have been larger, though there is no reason to think that it ever would be so large as on the plain. For the same reason, as soon as the process has been inverted, by which water was converted into air, the evaporation instantly takes place in the vapour that has been produced. We are to consider, that the atmosphere is never disposed to let fall *the whole* of the vapour it contains, for this would amount almost to an annihilation of it. Both processes go on at once; and it is only in particular parts that the reverse process takes place. Thus clouds are formed: but as these seldom continue stationary, they no sooner come into a situation where the contrary operation is going on, than they begin to evaporate; and even in the very same place, as soon as the condensing process has stopped, the other begins; as we see that even in the most damp and moist weather there is a constant evaporation going on; so that during the very time that rain is falling, the atmosphere is taking up what lies upon the ground.—Hence also we may see why the hygrometer indicated a greater degree of dryness in the night than in the day time, viz. because the evaporation from the earth is less during the night than in the day time.

²⁴
Electricity
of the at-
mosphere
considered.

II. Having now in some measure explained the phenomena of natural evaporation, we must next consider those of the *Electricity* of the atmosphere. Under the article *ELECTRICITY*, the nature of that fluid is so fully discussed, and its identity with the solar light rendered so probable, that there seems no farther occasion for entering into speculations upon the subject. We shall therefore, without taking any notice of the arguments of M. de Luc for its being a compound fluid, proceed to consider, according to the principles laid down in that article, how far electricity is concerned in producing the phenomena of meteorology.

²⁵
Different
agents con-
cerned in
producing
all meteors.

In this inquiry we must observe, that as none of the agents by which those phenomena are produced can act by themselves, but must always be assisted by the rest, so we are not to ascribe any one phenomenon to the influence of a single agent without the rest.—Thus, though in evaporation heat is principally concerned, and though evaporation is the principal cause of the appearance of clouds, &c. yet we do not find that heat is the *sole* cause of evaporation; neither is evaporation the sole cause of the appearance of clouds. In like manner, though electricity is the principal cause of many of the more grand phenomena of nature, yet electricity does not act by itself, but in conjunction with aqueous vapours; and when the atmosphere ceases to contain any of these vapours, it is highly probable that it ceases to manifest any of the common effects of electricity also.

²⁶
Electricity
of the earth
explained.

The general electricity of the earth has, under the article *ELECTRICITY*, been shown to depend upon the absorption of the rays of the sun by the land and water, especially by the latter. As this absorption must undoubtedly be strongest in those places where the greatest quantity of rays fall upon the surface, it follows, that the emission must be greatest where the fewest are absorbed; that is, at the poles. Hence, were there no obstacles, the electrical fluid would issue

forth in vast quantities at each pole, very little being emitted in the intermediate spaces. By reason of the resistance made by the great body of the earth, and the immense fields of snow and ice with which the polar regions are constantly enveloped, and which are much less perfect conductors than liquid water, the electric fluid, once absorbed, has no free passage through any particular part of the globe, and therefore forces out every where throughout the whole surface. This passage is facilitated by the moisture contained in the atmosphere; and thus the processes of evaporation and electricity assist one another: for where the air has for a long time been very dry, we find that the electric fluid cannot readily pass, and violent thunder and lightning, nay sometimes earthquakes, are ready to ensue. Hence also the common observation relative to thunder, viz. that there is seldom much thunder when it begins to rain before the thunder comes on: The reason is, that the rain, being an excellent conductor, facilitates the passage of the electric matter through the air, and keeps up the equilibrium without any violence or explosion.

As the electric matter gets out of the earth, it is naturally driven upwards to the higher parts of the atmosphere, where it probably assists in the decomposition of air, or resolving air into water, as has been already said. When clouds are formed, it presses strongly upon them by reason of their conducting nature: and hence all clouds, whether high or low, are found to be electrified; as are likewise all fogs, of whatever kind. The fluid getting still higher and higher, at last ascends beyond the regions of our atmosphere, into the unknown spaces which are the residence of those first of all created agents which conduct the planets round the sun, and act as the *primum mobile* of nature.

Thus there is a circulation in the electric fluid as there is in the water. It descends originally from the sun; pervades the whole substance of the globe; and perspiring, as it were, at every pore, ascends beyond the clouds; and, passing the extreme boundaries of our atmosphere, returns to the sun from whence it came. As the sphere of its action in returning, however, must always increase, it follows, that after it has got beyond the bounds of the atmosphere, the signs of its action must continually become less and less, nay, most probably vanish entirely; because it is there opposed by an immense quantity of similar matter, acting in an opposite or different direction from itself.

This last consideration leads into a very curious speculation, and in a very plausible manner answers an objection, the force of which it would otherwise be very difficult to avoid. “If the electric fluid be no other than the light of the sun absorbed by the earth, and emitted from it again by innumerable small vents, how comes it to pass that it is not perpetually drained off from the upper regions as fast as it arrives, without showing any sign of being resisted. The phenomena of thunder, of rain, nay of every meteor, manifestly show that it often meets with very great resistance; but this could not happen, unless there was without the atmosphere something capable of resisting and counteracting the vehement impulse of all the electric fluid with which the earth is filled. This resistance is very evident: for if there were none, there could

²⁷
How the e-
lectric mat-
ter is con-
fined in the
atmo-
sphere.

could not be any accumulation of electricity in the upper regions of the atmosphere, but a rarefaction in it would take place similar to what there is of air in the same regions. But this is so far from being the case, that all the electrical phenomena are much stronger in the upper than in the lower regions."

28
Mr Morgan's solution controverted.

To solve this objection, Mr Morgan, in a late paper in the Philosophical Transactions, supposes that an absolute vacuum, such as he imagines the celestial spaces to be, is absolutely impenetrable by the electric fluid. But this seems not far from a contradiction. Sir Isaac Newton imagined the celestial spaces to be void of all matter, on account of the apparent facility with which the planets move through them; and we see that the rays of light, the impulse of which is accounted scarce any thing at all, do penetrate them. To suppose, indeed, that a mere non-entity can act either by resistance or any way else, is an absurdity. How can any person imagine, that a perfect vacuum, which even a feather by its weight can cause it pervade from one end to the other, should be impenetrable by a flash of lightning? It is true, indeed, that from some experiments it is found, that when the air is exhausted very perfectly from a receiver, we cannot force an electric spark through it. But this, so far from proving that there is *nothing* in the glass, plainly shows that there is *something* in it which makes a greater resistance than we can overcome: and it is very probable that this something is no more than the electric fluid itself; for as we are very certain that the electric fluid can *impell*, so we are equally certain that it can *resist*. The truth is, that it is not in our power to move this fluid at all but by lessening in one part the resistance it meets with; in which case it moves very freely of itself: just as we can move the air with great facility, provided we allow the rest to follow; but if we attempt to push a quantity of air before us, without allowing any to follow it to supply the vacuity, we will meet with a most violent resistance. In the case of electric fluid, we can make it circulate from one part of the earth to another by means of conductors: but we cannot force any part of it to a distance from the rest, nor can we cause a small quantity expel a large one from any place, otherwise than by breaking the equilibrium; in which case the quantity which follows is precisely equal to that which went before. In the case of a perfect Torricellian vacuum, we cannot discharge a bottle through it, without setting in motion all that quantity which is contained in the glass, as well as all that is connected with it, which it seems is more than the power of any machine can do. In like manner, the atmosphere of the earth being surrounded by an immense and inconceivable quantity of electric matter, it cannot escape without putting in motion a quantity of that matter equal to what goes out. But this quantity, upon the whole, can never be greater than that which the earth every moment absorbs from the sun. Were a greater quantity to issue forth, it would be resisted by all the rest, even to the utmost boundaries of the universe; a power which no created being could overcome. As matters stand at present, the resistance is inconceivably great: for from the laws of mechanics it is evident, that action cannot exist without re-action; so that where there is no resistance, there can be no effort. In all cases we see that where the

electric matter has a good conductor, it moves silently, and without showing any marks of power whatever. If it meets with a small resistance it makes a small effort, and a greater one if a greater resistance is made, and so in proportion. The violence with which this fluid acts in some cases, shows the strength of the resistance to it all around; for, like other fluids, we are certain that this one also acts with equal force all around it, and the explosion is always made at the least resisting part. The electric fluid of the atmosphere, therefore, is confined by a very great power, which it is not by any means able to overcome, but which yields in a certain degree to its impulse every moment, in proportion to the fresh supplies yielded by it to the earth, and which supplies come every moment from the sun.

III. Heat and cold are very powerful agents in producing various meteors: but these are only relatives, and different modifications of the same fluid; the former being its action from a centre, the latter its action from a circumference to a centre. Though we do not know what connection there is between heat, cold, and what we call electricity, yet we know that this last is very much affected by them; for heat makes bodies more pervious to electricity than otherwise they would be, and cold makes them less so.—Hence the most violent electrical phenomena are observed in hot countries; while in the colder regions those which depend on a more moderate electrification, as auroræ boreales, are more frequent. The prevalence of heat and cold in particular places, however, depends upon circumstances which are altogether unknown to us; and therefore we cannot investigate the modes of their operation in such a particular manner as could be wished. From what has been already said, however, about the nature of the different agents concerned in meteorology, both in this article and in other parts of the work, we may take the following view of the causes of meteors in general.

1. Evaporation, combined with electricity, produces all the phenomena of vapour, fog, clouds, rain, &c.; and according as these two are joined to certain degrees of heat or cold, they produce dew, hoar-frost, rain, hail, or snow.

The phenomena of dew and hoar-frost seem to proceed from a quantity of aqueous and undecomposed vapour which always exists in the atmosphere; and which, being raised by mere heat, is condensed by mere cold, without undergoing that process by which water is changed into air. Hence it both ascends and descends; for if we cover a small space of ground with plates of glass, they will be wetted both above and below. The reason of this is, that the evaporation from the ground does not stop immediately after the air begins to cool, especially if it be covered with anything which prevents the access of the cold air, as the glass plates do in this case. The cold air, therefore, acting upon the glass, condenses the vapour below it, in the same manner that the head of a still or the receiver of a retort condenses the vapours which rise from the matter to be distilled. If the cold be very intense, hoar-frost appears instead of dew; which is nothing more than the dew frozen after it falls upon the ground, in the same manner that the vapour in a

29
Of heat and cold as agents.

30
Particular explanations of meteors.

warms

warm room congeals on the inside of the windows in a frosty night. As this seems to be the whole process, it has not been observed that any electricity is concerned in the production of dew.

When the vapour has been thoroughly decomposed, and become invisible, it very frequently returns back to its pristine state, so far as to assume the appearance of mist or fog. In this case, electricity appears evidently to be concerned; for Mr Cavallo has observed that all fogs are electrified. When the process has advanced farther, and the water begins to collect into drops, the electricity is still more remarkable; and it is with great reason supposed that it is by means of electrical repulsion that the drops of rain keep at a regular distance from one another. When the cold is intense, and the electricity strong, the drops of water are frozen, and hail is produced: but snow indicates a more moderate degree of electricity; and a very violent cold, accompanied with a strongly electrical atmosphere, produces that excessively disagreeable vapour in the polar regions called *frost-smoke*, which is a general congelation of all the aqueous moisture contained in the atmosphere.

2. By violent electricity alone are produced the phenomena of thunder, lightning, fire-balls, ignes fatui, and the aurora borealis. In the phenomena of thunder, evaporation and the other agents by which rain and hail are produced are also concerned; though electricity is most remarkably so, and thunder and lightning of the most violent kind frequently occur without any rain. The ignis fatuus, aurora borealis, large fire-balls, and the smaller ones called falling-stars, seem to depend upon electricity alone, without any aid from evaporation, or from heat or cold. Aurora borealis, indeed, is most common in the northern and southern parts of the world, where the cold is intense; though this seems to be owing, not to the cold, but to the natural emission of the electrical fluid from the polar regions in much greater quantities than from others. The fire-balls commonly appear collected on the very extreme boundaries of the atmosphere, where, from the violent resistance already mentioned, the fluid is confined as it were in a concave shell, which it cannot by any means penetrate in great quantities in any particular place. Though these fire-balls, therefore, contain an immense quantity of this fluid, they can only proceed in an horizontal direction, and never fly perpendicularly up from the earth, as those will sometimes do which are formed nearer the ground. The ignis fatuus seems to depend on the strong electricity of a certain portion of atmosphere, the cause of which is not well understood.

3. By the action of heat and electricity combined, are produced the phenomena of hurricanes, whirlwinds, and water-spouts. It is not, indeed, known in what manner those agents combine themselves to produce

such tremendous effects; but it seems evident that electricity is concerned in them, as the sea-water becomes unusually clear before an hurricane, and many signs of electricity are likewise observed in the heavens.

4. The winds are supposed to proceed mostly from the heat of the sun rarifying the atmosphere, and occasioning a continual influx of fresh air to fill up the vacuum; but very violent winds are frequently observed where no such cause can be supposed to exist.— Thus, on the tops of high mountains the winds are commonly very violent; and mountainous countries, especially when cold, are for the most part also subject to high winds. As the tops of mountains, however, are known to be strongly electrified by their attracting and repelling the clouds, we must suppose that this electricity has a considerable share in producing the winds which are generally so violent on their tops.— This will appear the more probable, when we consider that frequently storms of wind, and those of the most violent kind, seem to be brought along with clouds; as, for instance, that mentioned under the article MALTA, in which a dreadful tempest, brought along with a cloud, almost destroyed the whole town.

Thus we have endeavoured to give a general sketch of the doctrine of METEOROLOGY: a more particular detail of the causes by which meteors are produced is given under the names of each of them as they occur in the order of the alphabet. With regard to their uses, those of the more magnificent and tremendous kind seem to be destined to preserve the balance of the electric fluid in the atmosphere, the want of which would be productive of the most fatal effects to the world in general. The effects of the inferior ones are more confined, and are of use only to particular districts, scarcely ever extending their influence over a whole country. Thus the clouds, which produce rain for the purposes of vegetation, do not extend themselves over a whole country at once, but transitorily fly over different parts of it; so that when it is rain, for instance, in one place, it may be sunshine in another, thunder in a third, &c. It is, however, surprising to observe how equally these act over the whole of a very large tract of land; so that though there is never precisely the same weather in two places twenty miles distant from one another, yet vegetation goes on without any perceptible difference in the one as well as the other; neither, unless there be some very remarkable difference in the weather of one year from that of another, will there be any perceptible difference in the crop. For a more particular investigation of this point, however, see the articles VEGETATION and WEATHER.

For the application of meteorology to the foreknowledge of the weather, see the article WEATHER.

M E T

Meteoro-
mancy.

METEOROMANCY, a species of divination by meteors, principally by lightning and thunder. This method of divination passed from the Tuscans to the Romans, with whom, as Seneca informs us, it was held in high esteem.

M E T

METESSIB, an officer of the eastern nations, who has the care and oversight of all the public weights and measures, and sees that things are made justly according to them.

METHEGLIN, a species of mead; one of the most

Method, Methodists. most pleasant and general drinks the northern parts of Europe afford, and much used among the ancient inhabitants: (See MEAD). The word is Welsh, *med-dyglin*, where it signifies the same.—There are divers ways of making it; one of the best whereof follows: Put as much new honey, naturally running from the comb, into spring-water, as that when the honey is thoroughly dissolved an egg will not sink to the bottom, but be just suspended in it; boil this liquor for an hour or more, till such time as the egg swim above the liquor about the breadth of a groat; when very cool, next morning it may be barrelled up; adding to each 15 gallons an ounce of ginger, as much of mace and cloves, and half as much cinnamon, all grossly pounded; a spoonful of yeast may be also added at the bung-hole to promote the fermentation. When it has done working, it may be closely stopped up; and after it has stood a month, it should be drawn off into bottles.

METHOD, the arrangement of our ideas in such a regular order, that their mutual connection and dependence may be readily comprehended. See LOGIC, Part IV.

METHODISTS, in ecclesiastical history, is a denomination applied to different sects, both Papists and Protestants.

I. The *Popish Methodists* were those polemical doctors, of whom the most eminent arose in France towards the middle of the 17th century, in opposition to the Huguenots or Protestants. Those Methodists, from their different manner of treating the controversy with their opponents, may be divided into two classes. The one may comprehend those doctors, whose method of disputing with the Protestants was disingenuous and unreasonable, and who followed the examples of those military chiefs, who shut up their troops in intrenchments and strong holds, in order to cover them from the attacks of the enemy. Of this number were the Jesuit Veron, who required the Protestants to prove the tenets of their church by plain passages of scripture, without being allowed the liberty of illustrating those passages, reasoning upon them, or drawing any conclusions from them; Nihusius, an apostate from the Protestant religion; the two Walenburgs, and others, who confined themselves to the business of answering objections and repelling attacks; and cardinal Richelieu, who confined the whole controversy to the single article of the divine institution and authority of the church. The Methodists of the second class were of opinion, that the most expedient manner of reducing the Protestants to silence, was not to attack them by piecemeal, but to overwhelm them at once, by the weight of some general principle or presumption, some universal argument, which comprehended or might be applied to all the points contested between the two churches: thus imitating the conduct of those military leaders who, instead of spending their time and strength in sieges and skirmishes, endeavoured to put an end to the war by a general and decisive action. These polemics rested the defence of Popery upon prescription; the wicked lives of Protestant princes who had left the church of Rome; the crime of religious schism; the variety of opinions among Protestants with regard to doctrine and discipline; and the uniformity of the tenets and worship

of the church of Rome. To this class belong Nicolle the Jansenist doctor, the famous Bossuet, &c.

II. The *Protestant Methodists* form a very considerable body in this country. The sect was founded in the year 1729 by one Mr Morgan and Mr John Wesley. In the month of November that year, the latter being then fellow of Lincoln college, began to spend some evenings in reading the Greek New Testament, along with Charles Wesley student, Mr Morgan commoner of Christ-church, and Mr Kirkham of Merton-college. Next year two or three of the pupils of Mr John Wesley and one pupil of Mr Charles Wesley obtained leave to attend these meetings. Two years after they were joined by Mr Ingham of Queen's-college, Mr Broughton of Exeter, and Mr James Herve; and in 1735 they were joined by the celebrated Mr Whitefield, then in his 18th year.

At this time it is said that the whole kingdom of England was tending fast to infidelity. "It is come (says Bishop Butler), I know not how, to be taken for granted by many persons, that Christianity is not so much as a subject of inquiry, but that it is now at length discovered to be fictitious; and accordingly they treat it as if in the present age this were an agreement among all people of discernment, and nothing remained but to set it up as a principal subject of mirth and ridicule, as it were by way of reprisals, for its having so long interrupted the pleasures of the world." The Methodists are said, with great probability, to have been very instrumental in stemming this torrent. They obtained their name from the exact regularity of their lives; which gave occasion to a young gentleman of Christ-church to say, "Here is a new set of *Methodists* sprung up;" alluding to a sect of ancient physicians which went by that name. This extreme regularity, however, soon brought a charge against them, perhaps not altogether without foundation, of being too scrupulous, and carrying their sanctity to too great an height. In particular it was urged, that they laid too much stress upon the rubrics and canons of the church, insisted too much on observing the rules of the university, and took the scriptures in too literal a sense; and to the name of *Methodists* two others were quickly added, viz. those of *Sacramentarians* and the *Godly club*.

The principal person in this club while in its infancy appears to have been Mr Morgan, and next to him Mr John Wesley. They visited the sick, and instituted a fund for the relief of the poor; and the better to accomplish their benevolent designs, Mr Wesley abridged himself of all his superfluities, and even of some of the necessities of life; and by proposing the scheme to some gentlemen, they quickly increased their funds to 80 l. *per annum*. This, which one should have thought would have been attended with praise instead of censure, quickly drew upon them a kind of persecution; some of the seniors of the university began to interfere, and it was reported "that the college censors were going to blow up the Godly club*." * See Wesley's Life, p. 105. They found themselves, however, patronised and encouraged by some men eminent for their learning and virtue; so that the society still continued, though they had suffered a severe loss in 1730 in the death of Mr Morgan, who had indeed been the founder of it. In the month of October 1735, John and Charles Wesley,

Methodists. ley, Mr Ingham, and Mr Delamotte son to a merchant in London, embarked for Georgia along with Mr Oglethorpe, afterwards General Oglethorpe. The design of this voyage was to preach the gospel to the Indians. By this time, however, it appears, that Mr Wesley had embraced such notions as may without the least breach of charity be accounted fanatical. Thus in a letter to his brother Samuel, he conjures him to banish from his school "the classics with their poison, and to introduce instead of them such Christian authors as would work together with him in building up his flock in the knowledge and love of God."

During the voyage such a profusion of worship was observed, as we cannot help thinking favoured more of a Pharisaical than Christian behaviour; an account of which, as a similar strictness would certainly be inculcated upon the disciples, and consequently must give a just idea of the principles of the early Methodists, we shall here transcribe from Mr Wesley's Life. "From four in the morning till five each of us used private prayer; from five to seven we read the Bible together, carefully comparing it (that we might not lean to our own understandings) with the writings of the earliest ages; at seven we breakfasted; at eight were the public prayers; from nine to twelve learned the languages and instructed the children; at twelve we met to give an account to one another what we had done since our last meeting, and what we designed to do before our next; at one we dined; the time from dinner to four we spent in reading to those of whom each of us had taken charge, or in speaking to them separately as need required; at four were the evening prayers, when either the second lesson was explained (as it always was in the morning), or the children were catechised and instructed before the congregation; from five to six we again used private prayer; from six to seven I read in our cabin to two or three of the passengers, of whom there were about 80 English on board, and each of my brethren to a few more in theirs; at seven I joined with the Germans in their public service, while Mr Ingham was reading between decks to as many as desired to hear; at eight we met again, to instruct and exhort one another; between nine and ten we went to bed, when neither the roaring of the sea nor the motion of the ship could take away the refreshing sleep which God gave us."

As they proceeded in their passage, this austerity instead of being diminished was increased. Mr Wesley discontinued the use of wine and flesh; confining himself to vegetables, chiefly rice and biscuit. He eat no supper; and his bed having been made wet by the sea, he lay upon the floor, and slept soundly till morning. In his Journal he says, "I believe I shall not find it needful to go to bed, *as it is called*, any more;" but whether this was really done or not, we cannot say.

The missionaries, after their arrival, were at first very favourably received, but in a short time lost the affections of the people entirely. This was owing to the behaviour of Mr Wesley himself, who appeared not only capricious but frequently despotic. He particularly gave offence by insisting upon the baptism of children by immersion; and his excessive austerity with regard to himself did not tend to give his hearers any favourable

opinion either of the superior sanctity or wisdom of *Methodists* their teacher. At last, on account of a difference with Mr Causton the store-keeper and chief magistrate of Savannah, which ended in a law-suit, he was obliged to return to England.

Thus the cause of Methodism seemed to be entirely lost in Georgia. But Mr Wesley was soon succeeded by a more popular and successful champion, viz. Mr George Whitefield; who having spent his time during the voyage in converting the soldiers with whom he sailed, arrived at Savannah in Georgia on the 7th of May 1738. Here he was received by Mr Delamotte, was joined by several of Mr Wesley's hearers, and became intimate with some other ministers. Mr Ingham had made some progress in converting a few runaway Creek Indians, who had a settlement about four miles from Savannah; but being obliged to return to England in a few months, this design was frustrated, and the Indians in a few years separated. During the short time that Mr Whitefield resided at Savannah, he became extremely popular; and indeed the instances of his success in the way of making converts are very surprising. However, he was obliged to return to England in the autumn of that year, that he might receive priests orders. On his return to America in October 1739, he landed at Philadelphia, and instantly began his spiritual labours as in other places; being attended with astonishing success not only there but wherever he went. Passing through the colonies of Virginia, Maryland, North and South Carolina, the number of converts continually increased; but on his arrival at Savannah, he found the colony almost deserted. He now resumed the scheme he had formerly projected of building an orphan-house; and for this he made the first collection at Charlestown in South Carolina, amounting to about 70 l. sterling. His zeal in the cause of religion, or of the colony, were not, however, sufficient to procure him the favour of those in power. On his return to Philadelphia, after a short stay at Savannah, the churches were denied him; but he was made ample amends by the success which attended his field preachings and private efforts. Religious societies were every where set up, and many were converted with symptoms of enthusiasm, different according to their various tempers and constitutions. During this excursion, he was so successful in his collection for the orphan-house, that on his return to Savannah he brought along with him money and provisions to the value of 500 l. sterling.

The success in Georgia was now greater than ever; but the many charities which it was necessary to supply, rendered it necessary in a short time for him to undertake another journey to Charlestown. Here his principles met with the greatest opposition. He had lost the favour of the commissary by his field-preaching, and was denied the sacrament. The opposition, however, was altogether fruitless; the number of converts increased wherever he went, and he now undertook a voyage to New England. In this place also the established clergy were his enemies; but the usual success attended his other endeavours, and procured 500 l. more for the use of the orphans in Georgia.

From the year 1741 to 1742 America was deprived of Mr Whitefield's preachings, he having spent that interval in England; but in 1744 he again set out for the

Methodists, the western continent. The remarkable success which had hitherto attended his labours now stirred up many opponents; and these had met with the greater success, as none of the Methodist preachers whom he had left were possessed of such abilities either to gain the favour of those who heard them, or to defend their doctrines against objections. Mr Whitefield's success, however, was the same as before: he even found means to inspire the military class with such sentiments of devotion, that Colonel Pepperell could not undertake his expedition against Louisbourg without first consulting Mr Whitefield; and great numbers of New-Englanders went volunteers, confident of victory, in consequence of the discourses of their teacher.

From the continent of America Mr Whitefield took a voyage to the Bermudas islands; and here, as every where else, he met with the most surprising success. Here also collections were made for the Orphan-house in Savannah, which were transmitted to that place.

Supposing it to be better for his cause to visit different countries, than to take up a permanent residence in one, Mr Whitefield left Bermudas in a few months, and did not return to America till 1751, when the Orphan-house was found to be in a very flourishing situation. After a short stay, he set sail again for Britain. Here he remained two years, and then set out on another visit to America, landing at Charlestown on the 27th of May 1754. His presence constantly revived the spirits and cause of his party, and added to their numbers wherever he went. Next year he returned to England; but after labouring in the usual manner, and meeting with the usual success there till the year 1763, he set sail again for America, and arrived at Virginia in the latter end of August. He now visited all the colonies, and found that great progress had been made in converting the Indians. On his arrival at Georgia, matters were found in a very flourishing situation, and he received the thanks of the governor and principal people for the great benefit he had been to the colony; which shows, that the stories which had been so industriously propagated, concerning the avarice of him and other Methodist preachers, were, partly at least, unfounded. In 1765 he returned to England; and in 1769 made his seventh and last voyage to America, landing at Charlestown on the 30th of November the same year. He was still attended with the same success; and indeed it is impossible to read, without admiration, an account of the efforts made by himself and Mr Wesley, to propagate their tenets in the different parts of the world.

For a very considerable time Mr Whitefield was the only Methodist who paid any attention to America; and in that country he was more popular than even in Europe. Towards the end of his life several Methodists having emigrated from Britain, formed distinct societies in New York and Philadelphia. These quickly increased in number; and, about the time that the war with Britain began, their numbers amounted to about 3000 in Virginia, Maryland, New York, and Pennsylvania. They would probably have increased much more, had it not been for the imprudence of some of their preachers, who introduced politics into their discourses, and thus rendered themselves obnoxious to the people among

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whom they lived. Among those who hurt the cause *Methodists* in this manner was Mr Wesley himself, who, by writing a piece intitled *A Calm Address to the American Colonies*, would in all probability have ruined it, had not a gentleman, with whom he was connected, destroyed or sent back to England the whole impression as soon as it arrived in America, so that its existence was scarce known in that continent. At the conclusion of the war, Dr Coke, who in 1776 had left a curacy in England in order to join Mr Wesley, paid a visit to his friends in America; though it had been imagined that a total separation had taken place between the American and European Methodists. This breach was, however, made up by a manœuvre of Mr Wesley; for no sooner had the Americans obtained their independence, than he, who had hitherto branded them with the name of *rebels*, sent a congratulatory letter on their freedom from the "State and the Hierarchy," and exhorting them to "stand fast in that liberty with which God had so strangely made them free." To show his zeal in their service still farther, he gave ordination, by laying on of hands, to several preachers who were to embark for America, and consecrated Dr Coke one of the bishops of the Methodist Episcopal church in that country. He extracted also from the liturgy of the English church one for the American Methodists, taking particular care to expunge every expression that had a particular respect to the regal authority.

Such proceedings in one who had formerly professed such extraordinary attachment to the English church, could not but require an apology; and this was accordingly made in a pastoral letter transmitted to the American societies, and addressed "to Dr Coke, Mr Astbury, and our brethren in North America." In this letter he makes the following defence of his conduct. "Lord King's account of the primitive church convinced me, many years ago, that bishops and presbyters are the same order, and consequently have the same right to ordain. For many years I have been importuned, from time to time, to exercise this right, by ordaining part of our travelling preachers. But I have still refused; not only for the sake of peace, but because I was determined, as little as possible, to violate the established order of the national church to which I belonged. But the case is widely different between England and North America. Here there are bishops who have a legal jurisdiction; in America there are none, neither any parish-ministers: so that for some hundred miles together, there is none either to baptize, or to administer the Lord's supper. Here, therefore, my scruples are at an end; and I conceive myself at full liberty, as I violate no order, and invade no man's right, by appointing and sending labourers into the harvest. It has indeed been proposed to desire the English bishops to ordain part of our preachers for America; but to this I object. 1. I desired the bishop of London to ordain only one, but could not prevail. 2. If they consented, we know the slowness of their proceedings; but the matter admits of no delay. 3. If they would ordain them now, they would likewise expect to govern them; and how grievously would that entangle us. 4. As our American brethren are now totally disentangled, both from the state and the English

Methodists. glish hierarchy, we dare not entangle them again either with the one or the other. They are now at full liberty simply to follow the scripture and the primitive church; and we judge it best, that they should stand fast in that liberty wherewith God has so strangely made them free."

Dr Coke, on the consecration of Mr Astbury to the office of a bishop, made another apology. "The church of England (says he), of which the society of *Methodists* in general have till lately professed themselves a part, did for many years groan in America under grievances of the heaviest kind. Subjected to a hierarchy which weighs every thing in the scale of politics, its most important interests were repeatedly sacrificed to the supposed advantages of England. The churches were in general filled with the parasites and bottle-companions of the rich and great. The humble and most importunate intreaties of the oppressed flocks, yea the representations of a general assembly itself, were contemned and despised. Every thing sacred must bow down at the feet of a party; the holiness and happiness of mankind be sacrificed to their views; and the drunkard, the fornicator, and the extortioner, triumphed over bleeding Zion, because they were faithful abettors of the ruling powers. The memorable revolution has struck off these intolerable fetters, and broken the antichristian union which before subsisted between church and state. And had there been no other advantage arising from that glorious epoch, this itself, I believe, would have made ample compensation for all the calamities of the war; one happy consequence of which was the expulsion of most of those hirelings, who "eat the fat, and clothed themselves with the wool, but strengthened not the diseased," &c. The parochial churches in general being hereby vacant, our people were deprived of the sacraments through the greatest part of these states, and continue so still. What method can we take in so critical a juncture? God has given us sufficient resources in ourselves; and, after mature deliberation, we believe that we are called to draw them forth.

"But what right have you to ordain?" The same right as most of the churches in Christendom; our ordination, in its lowest view, being equal to any of the presbyterian, as originating with three presbyters of the church of England. "But what right have you to exercise the Episcopal office?" To me the most manifest and clear. God has been pleased to raise up, by Mr Wesley, in America and Europe, a numerous society well known by the name of *Methodists*. The whole body have invariably esteemed this man as their chief pastor under Christ. He has constantly appointed all their religious officers from the highest to the lowest, by himself or his delegate. And we are fully persuaded there is no church office which he judges expedient for the welfare of the people entrusted to his charge, but, as essential to his station, he has power to ordain. "But, do not you break the succession?" The uninterrupted succession of bishops is a point that has long been given up by the most able Protestant defenders of episcopacy. Bishop Hoadley himself, in his celebrated controversy with Dr Calamy, allows it to be unnecessary. His words are, 'To the 13th question I answer, that I think not an un-

interrupted line of succession of regularly ordained bishops necessary.' He also grants the authenticity of the anecdote given us by St Jerom, which informs us, that the church of Alexandria had no regular succession from the time of St Mark the evangelist, the first bishop of that church, to the time of Dionysius, a space of 200 years; but the college of presbyters, on the death of a bishop, elected another in his stead. We are also informed, from the epistle of St Clement to the Corinthians, written soon after the death of St Paul, a writer whose works are next in precedence to the canon of scripture, and probably written by immediate inspiration, that the church of Corinth was then governed only by a college of Presbyters. And from the epistle of Polycarp to the church of Philippi, written in 116, we also find that the Christian Philippians were then governed only by a college of Presbyters. So that the primitive Christians were so far from esteeming the regular succession as essential to the constitution of a Christian church, that, in some instances, episcopacy itself was wholly omitted."

Such was the defence urged by Mr Wesley for this extraordinary assumption of episcopal powers: a conduct, however, of which he afterwards repented, as tending to make a final separation betwixt his followers and the church of England. Yet it does not appear that this had any bad effect on the minds of his American brethren; for Dr Coke, on his arrival on the western continent, found the societies numerous and flourishing. His first efforts were directed against the slave-trade; and not only the abolition of that traffic, but the release of all those who were actually slaves at the time, seem to have been his favourite objects. By interfering in this matter, however, perhaps with too much zeal, he involved himself in danger. Some riots took place, and a lady offered the mob 50 guineas if they would give the Doctor 100 lashes. This piece of discipline would have been inflicted, had it not been for the interposition of a sturdy colonel; and the Doctor had not only the satisfaction of escaping the intended punishment, but of seeing his doctrine so far attended to, that some slaves were emancipated.

Mr Hanson, in his Memoirs of Mr Wesley, observes, that "the colonists, in the infancy of Methodism, conducted themselves with more propriety than the English. There was little or no persecution, nor any thing like a riot, except in one or two instances which have been mentioned as the consequence of the animadversions on slavery; and even these were productive of no mischief. Not a creature was materially injured; no bones were broken, nor any lives lost; which was not the case in this country. Here many thousands of innocent people were subjected to the grossest indignities, and several were eventually sacrificed to the fury of their persecutors.

"While we commend the Americans for their behaviour in opposition to the brutality of English mobs, it may be proper to inquire into the sources of this distinction. Something of this may have arisen from similarity of sentiment. The Americans, from the first beginnings of colonization, had been accustomed to the doctrines of the old puritans and nonconformists, which in many respects have a near affinity to the *Methodistic* tenets. The origin of Methodism in America

Methodists. rica was seldom, if ever, attended, either under the discourses of Mr Whitefield's or Mr Wesley's preachers, with those ridiculous effects with which it was accompanied in these kingdoms. Most of the preachers, who went over to the continent, having laboured for some years in Europe previous to their having crossed the water, had exhausted their wild-fire; so that their discourses were more scriptural and rational than those of the primitive Methodists. Another reason may be found in the education of the Americans. As a people, they are better cultivated than the body of the English; they are chiefly composed of merchants and a respectable yeomanry: and there is but a small proportion of that class so superabundant here which we distinguish by the name of *mob*.

"The only exception we have heard, to their exemption from the extravagancies which in this country marked the infancy of Methodism, is a custom they have introduced in Maryland and Virginia. Frequently, at the conclusion of a sermon, the whole congregation begin to pray and to praise God aloud. The uproar which this must create may easily be conceived. Some, we are told, are great admirers of this species of enthusiasm, in which every man is his own minister, and one sings and another prays, with the most discordant devotion. But we will not dignify such indecency with such a name. Its proper appellation is *fanaticism*. We hope, that, for the future, religion will never appear in this country under so odious a form; and greatly is it to be lamented, that, among the friends of Christianity, any such absurdities should arise, to furnish infidels with occasions of triumph."

Our author informs us, that the occupation of the Methodist preachers in America was very laborious. In the course of the day they frequently rode 20 or 30 miles, preaching twice or thrice, and sometimes to considerable congregations. Notwithstanding this labour, however, few or none of them ever thought of returning to Britain. Several reasons may be assigned for the pleasure they took in this laborious exercise. "Their excursions (says Mr Hanson) thro' immense forests abounding in trees of all sorts and sizes, were often highly romantic. Innumerable rivers and falls of water; vistas opening to the view, in contrast with the uncultivated wild; deer now shooting across the road, and now scouring through the woods, while the eye was frequently relieved by the appearance of orchards and plantations, and the houses of gentlemen and farmers peeping through the trees; formed a scenery so various and picturesque, as to produce a variety of reflection, and present, we will not say to a philosophic eye, but to the mind of every reasonable creature, the most sublime and agreeable images.

"Their worship partook of the general simplicity. It was frequently conducted in the open air. The woods resounded to the voice of the preacher, or to the singing of his numerous congregations; while their horses, fastened to the trees, formed a singular addition to the solemnity. It was indeed a striking picture; and might naturally impress the mind with a retrospect of the antediluvian days, when the hills and valleys re-echoed the patriarchal devotions, and a Seth or an Enoch, in the shadow of a projecting

rock, or beneath the foliage of some venerable oak, Methodists. delivered his primeval lectures, and was a "preacher of righteousness to the people."

The American hospitality is supposed by Mr Hanson to have been another reason for the assiduity of the Methodist teachers, as well as the consciousness of being well employed, and the satisfaction resulting from considerations of public utility. As many of the preachers were men of fervent piety, this reflection would have its full weight; and the instruction of the ignorant and the reformation of the profligate would be considered as the best recompence of their labours. Spreading themselves through the continent, they took in Nova Scotia, Georgia, with the principal places in both Carolinas, Virginia, Maryland, Delaware, Pennsylvania, New Jersey, and New York; numbering upwards of 43,000 members of their society, exclusive of about 80 itinerants, and a considerable number of local preachers, who took no circuits, but assisted occasionally in the neighbourhood of their respective residence.

The large and expensive buildings which the colonists have erected for public worship, almost exceed credibility; and several colleges are founded for the instruction of youth. How far the proposed plan of uniting genuine religion and extensive learning will be carried into execution, time only can discover. It must materially depend on the character of the presidents and tutors, and the provision that shall be made for their support. Men of real erudition will never be procured at low salaries; and it is in vain to attempt establishments of this sort without a liberal provision for the professors in every branch of science. Two of these places are called *Cokesbury* and *Wesley Colleges*. How they are endowed, or whether they propose to obtain authority to confer degrees, we are not informed. - But perhaps they are rather schools than colleges; which indeed is a circumstance to be wished, as good grammar-schools are of the utmost service to the progress of literature.

The great success which attended the Methodist preachers in America naturally determined Mr Wesley to try the West India islands. The Moravians had already attempted to establish their principles in some of these islands; and in 1786 some preachers were sent from the Methodists in England to the West Indies. In many of these they met with success. Societies were formed in Barbadoes, St Vincent's, Dominica, St Christopher's, Nevis, Antigua, St Eustatius, Tortola, and St Croix, amounting in all to near 5000 persons. At this time the whole number of Methodists in America and the West Indies amounted to about 48,302. These societies consist both of whites and blacks: on the continent they were mostly whites, but in the islands negroes. "But it is to be observed (says Mr Hanson) that the subjection of the negroes, and the obedience in which they are trained, must inculcate a docility peculiarly favourable to the purposes of a mission." Some of the missionaries went also to St Vincent's, where they met with some success, and have established some schools, in which their children are carefully instructed in the principles of religion.

"In January 1789 (says our author), Dr Coke paid a visit to Jamaica, and gave them several ser-

Methodists. mons. As he made but a short stay, it could hardly be considered as a fair trial. Should a mission be established here, as well as in the other islands, which will probably be the case, it is hoped it will be the means of correcting one vice at least, and that is duelling; a savage relic of Gothic barbarity, by which all the islands have for many years been distinguished. Perhaps too it will give some check to the spirit of luxury and dissipation; and teach the planters, if it be found impracticable to emancipate their slaves, at least to treat them with humanity."

It has been debated among the leading men of the Methodistical profession, whether the cause might not be served by sending missionaries to the East Indies and to Africa; but these projects were dropped, as there was no invitation, nor any prospect of success if it had been adopted. A mission has been formed to the new settlement called *Kentucky*, on the confines of the Indian territories, near the Mississippi. The danger of the missionaries at the time they undertook this service was certainly very great; yet such was their zeal for the cause, that they voluntarily offered themselves: but we are not yet informed what success they have met with.

While Methodism was thus making rapid progress in America, its teachers were equally indefatigable in Britain. A most remarkable particular, however, occurs with regard to Mr Wesley himself; for though he had gone to Georgia, as has been already related, to convert the Indians to Christianity, yet on his return to England in 1738, he took it into his head that he, their teacher, was not yet converted: the reason was, that he had not the faith of assurance. This, however, was not long wanting. He arrived in England on the first day of February, and was blest with the assurance on the sixth of March following. This was immediately announced to the public; and the consequence, if we may believe him, was, that God then began to work by his ministry, which he had not done before. Being joined by one Kinchin, a fellow of Corpus, they travelled to Manchester, Holms Chapel, Newcastle in Staffordshire, and other places, where they preached, exhorted, and conversed on religious subjects, in public-houses, stables, &c. sometimes meeting with success and sometimes not. During this peregrination Mr Wesley certainly displayed a great deal of superstition, which we must undoubtedly suppose to have been communicated to his hearers, and to have caused them act on many occasions in a very ridiculous manner. An instance follows:—"The next day (says he), March 11th, we dined at Birmingham, and, soon after we left it, were reproved for our negligence there (in letting those who attended us go without either exhortation or instruction) by a severe shower of hail!" About the latter end of March or beginning of April he and his companion began to pray *extempore*, leaving off entirely the forms of the church of England, to which he had formerly been so devoted. The doctrine of instantaneous conversion, which his imagination had suggested to him as a work performed on himself, was greedily received by some of his hearers, and all the converts to the new doctrine confirmed themselves, and contributed greatly to persuade others by declarations of their *experiences*, as they called them: how-

ever, though a knowledge of the saving assurance had been given on March 6th, he does not date his conversion sooner than May 24th of the same year.

This new doctrine of an instantaneous, and in fact miraculous impulse, though greatly relished by the enthusiastical part of the society, was very much disliked by others, particularly Mr Charles Wesley his brother, who warned him of the mischief he was doing; though he himself was soon converted, and, what is very astonishing, two days before John Wesley himself. The particulars related of these miraculous conversions are truly disgraceful, and could not but bring into contempt the society which consisted of such enthusiasts. "Many (says Mr Hanson) are represented as falling suddenly to the ground, in horror and agony not to be conceived, and rising again with equal expressions of peace and consolation."—Their conversions were usually attended with these violent symptoms; and, for several years, few meetings occurred where Mr Wesley presided, without one or more instances of the same kind. It was not possible that such transactions should pass without notice. The confusion that too often prevailed, the emotions of the persons affected, and the exultations of the rest, which were severally animadverted upon, gave great and general offence. Many insisted, that it must either be occasioned by the heat of the rooms, and the agitation of the animal spirits under discourses of the most alarming nature; or that it was mere artifice and hypocrisy.

In the mean time, two of the sons of a Mrs Hutton in London, happening to become converts to the new doctrine, this lady was so much offended, that she wrote to Mr Samuel Wesley, informing him, that she was of opinion his brother John had lost his senses; and requesting, that the next time he came to his house, he, Mr Samuel, would either confine or convert him. All that could be done, however, to prevent the progress of the new doctrine was insufficient; and the first Methodist society was formed in London, on the first of May 1738, when about 50 agreed to meet together once a-week for free conversation, begun and ended with singing and prayer.

All this time, however, it seems that the conversion of Mr Wesley was far from being so complete as that of many of his hearers. He had preached and converted others, while he himself was absolutely unconverted. The knowledge of the true saving faith was only revealed to him on the 6th of March, and he did not experience its power till the 24th of May; and even after this, his doubts and fears were still so great, that on the 13th of June he undertook a voyage to Germany, where, in the company of Count Zinzendorff, his faith seems to have been thoroughly confirmed.

On Mr Wesley's return, September 16th, 1738, he applied himself with the greatest assiduity and success to the propagation of his doctrine. Multitudes of converts were made in various parts of the kingdom; and the reproaches poured upon him by his opponents, seemed to have rendered his zeal more fervent if possible than before. It is remarkable, however, that some of his old friends were now so much offended with his conduct or his principles, that they absolutely refused to keep company with him. His original

Methodists. original plan seems to have been, to make an union of clergymen, and disseminate his principles by their means. But in this he succeeded so ill, that in a letter written in 1742, he wished for a clerical assistant, were he only in deacons orders: but adds, "I know of none such, who is willing to cast in his lot with us; and I scarce expect I shall, because I know how fast they are rivetted in the service of the devil and the world before they leave the university."—Finding at last that nothing could be done with them, he was obliged to have recourse to lay preachers; and easily selected those who appeared to have the greatest talents for prayer and exhortation in the private meetings appointed for that purpose. Thus he at once raised himself to be the head of a sect; as the lay-preachers willingly yielded obedience to him who had the advantages of superior learning and abilities, and was besides in orders as a clergyman; and this obedience he did not fail on every occasion to exact.

If his doctrine had formerly given offence to the established clergy, the appointment of lay preachers was reckoned much worse; and their being appointed without any form of ordination whatever, which almost all of them were, subjected them to contempt and reproach, which their want of learning, and very often of natural abilities, did not contribute to remove. Thus finding the churches shut against him and his followers, he was obliged to preach in the fields, and made his first essay in this way on the second of April 1739, in the neighbourhood of Bristol; Mr Whitefield having set him an example the day before.

The success of those ignorant and itinerant preachers, with their absurd and uncharitable discourses and behaviour, so provoked their adversaries, that a persecution was soon commenced against them. Mr Wesley himself was calumniated in the harshest manner, being sometimes said to be a Jesuit, sometimes an illiterate enthusiast, as the people took it into their heads. Many pretended to answer him in writing, without being able to do so: the consequence was, that their deficiency of argument was supplied by invective, and the most scandalous performances made their appearance. Some of the English clergy so far forgot themselves as to instigate the mob against them, and the most cruel outrages were committed upon them in various places. For some time the persecuted party adhered to the doctrines of passive obedience and non-resistance, which their inhuman adversaries did not fail to take the advantage of.—The less they were opposed, the more insolent they became. The Methodists were frequently in danger of their lives. Men, women with child, and even children, were knocked down and abused with the same undistinguishing fury. Houses were stripped of their furniture, vast quantities of furniture carried off, feather-beds cut in pieces and strewed over the streets, several reputable people were forced into the army, &c. To the disgrace of magistracy also it was found, that when application was made to the justices of the peace, redress was commonly denied; nor was a stop put to these shameful proceedings without a royal mandate for the purpose.

From the year 1738 to 1747 Mr Wesley and his itinerants were employed in various parts of England.

In 1747 he went over to Dublin, where a society had been formed by one Mr Williams a clergyman.—Here they proved so successful, notwithstanding the number of Papists, and the violence of their other opponents, that in 1750 they had erected meeting-houses in every part of the kingdom, and had formed 29 circuits, which employed 67 itinerants, besides a considerable number of local preachers. An invitation was given to Mr Wesley, in 1751, to visit Scotland, by an officer in quarters at Muffelburgh. He accordingly took a journey thither the same year; but left the place, after preaching in it once or twice. In 1753 he returned to Scotland, and visited Glasgow. Societies were at length formed in that city, as well as at Edinburgh, Dundee, Aberdeen, Inverness, and a few other places: but his success was by no means equal to what it had been in other parts; for in 1790 the number of circuits in Scotland was no more than eight, which were supplied by 20 itinerants.

Mr Whitefield, the other great labourer in the vineyard, was equally indefatigable, and probably more successful than Mr Wesley. Before entering into orders, he had formed a society of religious persons at Gloucester: here he preached his first sermon on the Necessity and Benefit of Religious Society; here he became extremely popular, as well as at Bristol and London, while preparing to set sail for Georgia for the first time; and in all places to which he came, large collections were made for the poor. He maintained the same doctrine with Mr Wesley as to the new birth; which likewise gave offence to the clergy when delivered by him, as it had done with Mr Wesley. In the various intervals of his voyages to America, he employed himself with the very same assiduity in Britain and in Ireland, which we have already taken notice of in the western continent. His success was every where prodigious. In 1741 he was invited to Scotland, and preached his first sermon there at Dunfermline. From thence he went to Edinburgh, and preached in several of the established churches, but differed with Messrs Ralph and Ebenezer Erskines; so that he, as well as Mr Wesley, proved unsuccessful in forming a coalition with any other religious party. In the private way, however, his success was very considerable, at Edinburgh, Glasgow, Aberdeen, Dundee, and other places. In 1742 he paid a second visit to Scotland, and a third one in 1748. In 1751 he visited Ireland for the first time; and preached to great multitudes, without being molested, even in places where others had been mobbed. From thence he returned to Scotland the same year, and speaks in very favourable terms of the attention the people there paid to their bibles. In 1752 and 1753 he again visited the same kingdom, and the last time distinguished himself by preaching against the playhouse in Glasgow. In 1756 he returned; and by his animated discourses at Edinburgh against Popery and arbitrary power, was owned to have contributed very much to the increase of courage and loyalty in this country. Next year he again visited the Scottish capital during the time that the General Assembly sat, and his sermons were attended by several of the members. At Glasgow he made a large collection for the poor of that city, and from thence took

Methodists. a voyage to Ireland. He was received with the usual affection by the lower classes of Protestants; but the Popish rabble, exasperated at his success, almost murdered him with stones. After passing through a great part of Ireland, visiting England and Wales, he paid another visit to Scotland, where four clergymen now lent him their pulpits. His last visit was in the summer of 1758, where his congregations were as large as ever; and it is to his endeavours principally that we are to ascribe the great number of Methodist societies now existing in Scotland.

History of Methodism, &c. With regard to the religious principles of the Methodists, we cannot enter into any particular detail; neither indeed are there any doctrines peculiar to all included under that name, except the single one of salvation by faith without works. In March 1741, Mr Whitefield being returned to England, entirely separated from Mr Wesley and his friends, "because he did not hold the decrees."—Here was the first breach, which warm men persuaded Mr Whitefield to make, merely for a difference of opinion. Those indeed who believed universal redemption, had no desire at all to separate: but those who held particular redemption, would not hear of any accommodation, being determined to have no fellowship with men that "were in such dangerous errors." So there were now two sorts of Methodists so called; those for particular, and those for general, redemption.

Not many years passed, before William Cudworth and James Rely separated from Mr Whitefield.—These were properly Antinomians, absolute avowed enemies to the law of God, which they never preached or professed to preach, but termed all *Legalists* who did. With them, preaching the law was an abomination. They had nothing to do with the law. They would preach Christ, as they called it; but without one word either of holiness or good works. Yet these were still denominated *Methodists*, although differing from Mr Whitefield both in judgment and practice, abundantly more than Mr Whitefield did from Mr Wesley.

In the mean time, Mr Venn and Mr Romaine began to be spoken of: and not long after Mr Madan and Mr Berridge, with a few other clergymen, who, although they had no connection with each other, yet preaching salvation by faith, and endeavouring to live accordingly, to be Bible-Christians, were soon included in the general name of *Methodists*. And so indeed were all others who preached salvation by faith, and appeared more serious than their neighbours. Some of these were quite regular in their manner of preaching: some were quite irregular, (though not by choice; but necessity was laid upon them, they must preach irregularly, or not at all): and others were between both; regular in most, tho' not in all particulars.

In 1762, George Bell and a few other persons began to speak great words. In the latter end of the year they foretold that the world would be at an end on the 28th of February. Mr Wesley, with whom they were then connected, withstood them both in public and private. This they would not endure: so, in January and February 1763, they separated from

him, under the care of Mr Maxfield, one of Mr Wesley's preachers. But still Mr Maxfield and his adherents, even the wildest enthusiasts among them, go under the general name of *Methodists*, and so bring a scandal upon those with whom they have no connection.

At present, those who remain with Mr Wesley are mostly Church-of-England men. They love her articles, her homilies, her liturgy, her discipline, and unwillingly vary from it in any instance. Meantime, all who preach among them declare, *we are all by nature children of wrath, but by grace we are saved through faith*; saved from both the guilt and from the power of sin. They endeavour to live according to what they preach, to be plain Bible-Christians; and they meet together at convenient times, to encourage one another therein. They tenderly love many that are Calvinists, though they do not love their opinions. Yea, they love the Antinomians themselves; but it is with a love of compassion only, for they hate their doctrines with a perfect hatred; they abhor them as they do hell-fire: being convinced nothing can so effectually destroy all faith, all holiness, and all good works.

We shall conclude this article with the words of Mr Hanson, which must certainly be accounted just, whatever objections may be made to some parts of the principles or behaviour of the Methodists. "If they possess not much knowledge, which, however, we do not know to be the case, it is at least certain, they are not deficient in zeal: and without any passionate desire to imitate their example, we may at least commend their endeavours for the general good. Every good man will contemplate with pleasure the operation of the spirit of reformation, whether foreign or domestic; and will rejoice in every attempt to propagate Christianity in the barbarous parts of the world: An attempt which, if in any tolerable degree successful, will do infinitely more for their civilization and happiness, than all the united energies of those boasted benefactors of mankind, the philosophic infidels."

METHODISTS (*Methodici*), in the history of medicine, a sect of ancient physicians, who reduced the whole art of healing to a few common principles or appearances. The Methodists were the followers of Theffalus; whence they were also called *Theffalici*. They were strenuously opposed by Galen in several of his writings; who scrupled not to assert, that the methodical heresy ruined every thing that was good in the art.

Quincy mistakenly uses *Methodists* (*Methodici*) for those physicians who adhere to the doctrine of Galen, and the schools; and who cure with bleeding, purges, &c. duly applied according to the symptoms, circumstances, &c. in opposition to empirics and chemists, who use violent medicines, and pretended secrets or nostrums.

METHODIUS, a father of the church, bishop of Olympus or Patara in Lycia, and afterward of Tyre in Palestine, suffered martyrdom at Chalchis in Greece towards the end of Dioclesian's persecution in the year 302. He composed many works in a clear and elaborate style, which were extant in Jerome's time. Father Combefis collected several considerable fragments of this writer, cited by Epiphanius, Photius, and others;

Methodists; Methodius.

Methuselah others; and printed them with notes of his own, together with the works of Amphilochius, and Andreas Cretensis, in folio, Paris 1644.

Metoposcopy.

METHUSELAH, the son of Enoch and father of Lamech, was born in the year of the world 687, begat Lamech in 874, and died in 1656, being the very year of the deluge, at the age of 969, which is the greatest age that has been attained to by any mortal man upon earth (Gen. v. 21, 22, &c.) According to the text of the septuagint, Methuselah must have lived 14 years after the deluge; and according to other copies, he died six years before it: but it is generally agreed on, that these copies, as well as the septuagint, are corrupted in this place.

METHYMNA (anc. geog.), a town of the island of Lesbos. It was the second city of the island in greatness, population, and opulence. Its territory was fruitful, and the wines it produced excellent. It was the native place of Theophrastus, and of Arion the musician. When the whole island of Lesbos revolted from the power of the Athenians, Methymna alone remained firm to its ancient allies.

METIUS (James), of Alcaer, in Holland, the inventor of telescopes with glasses, one of which he presented to the States-General in 1609. Tubes, extended, by uniting them, to a great length, were known to the ancients; but Metius was the first who added glasses, and he was indebted to chance for the discovery: he had frequently observed some school-boys playing upon the ice, who made use of their copy books rolled up in the shape of tubes, to look at each other, to which they sometimes added pieces of ice at each end, to view distant objects: this led him to the invention of optic glasses.

METO, a famous mathematician of Athens, 432 B. C. published his *Anneadecatoride*, that is, his "Cycle of Nineteen Years," by which he endeavoured to adjust the course of the sun to that of the moon, and to make the solar and lunar years begin at the same point of time.

METECI, a name given by the Athenians to such as had their fixed habitations in Attica, though foreigners by birth. The *meteci* were admitted by the council of Areopagus, and entered in the public register. They differed both from the *πολιται* and *Ξενοι*; because the *politæ* or "citizens" were freemen of Athens, and the *xeni* or "strangers" had lodgings only for a short time; whereas the *meteci*, though not freemen of Athens, constantly resided upon the spot whether they had removed.

METONYMY, in rhetoric, is a trope in which one name is put for another, on account of the near relation there is between them. See ORATORY, n° 51.

METOPE, in architecture, is the interval or square space between the triglyphs of the Doric freeze, which among the ancients used to be painted or adorned with carved work, representing the heads of oxen or utensils used in sacrifices.

METOPOSCOPY, the pretended art of knowing a person's dispositions and manners by viewing the traces and lines in the face. Ciro Spontoni, who has written expressly on metoposcopy, says, that seven lines are examined in the forehead, and that each line is considered as having its particular planet: the first is

the line of Saturn, the second of Jupiter, the third of Mars, &c. Metoposcopy is only a branch of physiognomy, which founds its conjectures on all the parts of the body.

METRE, *μετρία*, in poetry, a system of feet of a just length.

The different metres in poetry, are the different manners of ordering and combining the quantities, or the long and short syllables: thus hexameter, pentameter, iambic, sapphic verses, &c. consist of different metres or measures. See HEXAMETER.

The English verses, the metres are extremely various and arbitrary, every poet being at liberty to introduce any new form that he pleases. The most usual are the heroic, generally consisting of five long and five short syllables, and verses of four feet, and of three feet, and a cæsura or single syllable.

The ancients, by variously combining and transposing their quantities, made a vast variety of different measures, by forming spondees, &c. of different feet. See POETRY.

METRETES, a Grecian measure, containing something more than nine English gallons. See MEASURE.

METRICAL VERSES, are those consisting of a determinate number of long and short syllables; as those of the Greek and Latin poets.—Capellus observes, that the genius of the Hebrew language is incompatible with metrical poetry.

METRODORUS, a Greek physician, born at Chios, was the disciple of Democritus the philosopher, and the master of Hippocrates the physician and Anaxarchus the philosopher. He maintained that the universe is infinite and eternal: but his works are lost. He lived about 444 B. C.

METROCOMIA (from *μητηρ* mother, and *κωμην* town or village), a term in the ancient church-history, signifying "a borough or village that had other villages under its jurisdiction."—What a metropolis was among cities, a *metrocomia* was among country towns. The ancient *metrocomiæ* had each its choriepiscopus or rural dean, and here was his see or residence. See METROPOLIS and CHORIEPISCOPUS.

METRONOMII, the name given by the Athenians to five officers in the city and ten in the *piræus*, whose duty it was to inspect all sorts of measures except those of corn. The *piræus* was the greatest mart in Attica.

METROPOLIS (from *μητηρ* mother, and *πολις* city), the capital of a country or province; or the principal city, and as it were mother of all the rest.

The term **METROPOLIS** is also applied to archiepiscopal churches, and sometimes to the principal or mother-church of a city. The Roman empire having been divided into 13 dioceses and 120 provinces, each diocese and each province had its metropolis or capital city, where the præconsul had his residence. To this civil division the ecclesiastical was afterwards adapted, and the bishop of the capital city had the direction of affairs, and the pre-eminence over all the bishops of the province. His residence in the metropolis gave him the title of *metropolitan*. This erection of metropolitans is referred to the end of the third century, and was confirmed by the council of Nice.

Metre
Metropolis.

Metulum A metropolitan has the privilege of ordaining his suffragans; and appeals from sentences passed by the suffragans are preferred to the metropolitan.

||
Meulen.

METROPOLIS (anc. geog.), a town of Acarnania, a little to the south of Stratos.—Another, of Lydia; situated between Colophon and Priene, near the Cayster.—A third, of Phrygia; sacred to the mother of the gods, who was here worshipped.—A fourth Metropolis of Estiotis, a district in Thessaly, to the east of Gomphi, and the last town of that district. *Metropolitæ*, the people.

METULUM (anc. geog.), a considerable city of Liburnia, at the siege of which Octavius Cæsar was wounded. Said to be the metropolis, and situated on two eminences, intersected by a valley (Appian.) Now generally thought to be *Metling* in Carniola. E. Long. 16. N. Lat. 46. 5.

METZ, an ancient, large, and strong town of France, and capital of the territory of Meffin, with a citadel, a parliament, and a bishop's see, whose bishop assumes the title of a prince of the empire. The cathedral church is one of the finest in Europe, and the square called *Coffin* and the house of the governor are worth seeing. The Jews live in a part of the town by themselves, where they have a synagogue. The sweetmeats they make here are in high esteem. It is seated at the confluence of the rivers Moselle and Seille. E. Long. 6. 16. N. Lat. 49. 7.

METZU (Gabriel), an eminent painter, was born at Leyden in 1615. His subjects were usually taken from low life; but they were all designed after nature, and surprisingly well represented; such as women selling fish, fowls, or hares; sick persons attended by the doctor; chemists in their laboratories; dead game, painters rooms, shops, and drawing schools hung with prints and pictures; all which subjects he composed well, and finished them with extreme neatness, as he likewise did his portraits. He spent a great deal of time on his pictures, which has occasioned their scarcity and dearness at this time; and besides, it is confidently said, the Dutch prevent their being carried out of their own country, as much as possible. So that those paintings of Metz, which are sometimes seen in the collections of our kingdoms, are either obtained by chance, or purchased at large prices. Though it ought also to be remembered, that the value set upon the works of this master throughout Holland and Flanders, has induced several painters to endeavour at imitating and copying his works, which having gradually circulated abroad and being a little mellowed by time, are now called originals. He died in 1658.

MEVANIA (anc. geog.), a town of the Cisapennine Umbria; seated at the confluence of the Tina and Clitumnus, on the Via Flaminia, famous for its herds of white cattle brought up there for sacrifice; the white colour said to be owing to the waters of the Clitumnus (Virgil). Mevania was the country of Propertius. *Mevenates* the people. Now said to be *Bevagna*, in the territory of the Pope.

MEULEN (Anthony Francis Vander), painter of battles, &c. was born at Brussels in 1634; and was a disciple of Peter Sneyers, a battle-painter of considerable note. Some of his compositions happening to be carried to Paris, were shown to M. Colbert; who

N° 216.

soon discerned the abilities of Vander Meulen, and by his generous offers induced him to leave his native city and settle at Paris. Here he was employed by Louis XIV. and had an appointment of 2000 livres pension, beside being paid for his work. He attended that monarch in most of his expeditions in the field, and designed on the spot the sieges, attacks, encampments, and marches, of the king's armies, also the views of those cities and towns memorable by any degree of success; and from those sketches he composed the paintings, which were intended to perpetuate the remembrance of those military exploits. He died in 1690. The principal works of this master are at Versailles and Marli; but many of his easel pictures are dispersed through England, France, and Flanders.

MEURSIUS (John), a learned and laborious writer, born at Lisdun, near the Hague, in 1579. He early discovered a fondness for polite literature and the sciences; and went to study the law at Orleans with the son of Barneveldt, whom he accompanied in his travels. In 1610 he was made professor of history at Leyden, and afterwards Greek professor. In the following year, the magistrates of the United Provinces proved how high their opinion was of his abilities, by fixing on him to write the history of his country. Meursius married in the year 1612. His wife, Anna Catherina Bilberbeccia, descended from a very ancient and noble family in Angermund a city of Pomerania, possessed many amiable qualities, and rendered his domestic life remarkably happy, while he discharged the duties of his professorship with an assiduity equal to his abilities. At the same time the republic of letters did not lose the advantages to be derived from his labours; for during the fourteen years of his residence at Leyden, the works which he published were more numerous than those which had been presented to the world by the whole body of professors from the original foundation of the university in 1575.

Meursius's writings had now disseminated his reputation in every part of Europe; nor had the fame of his diligence and talents as a professor spread with less rapidity. In so high a rank, indeed, did he stand among his literary contemporaries, that Christian IV. king of Denmark conferred on him the place of historiographer royal, and invited him to undertake the professorship of history and politics in the academy of Sora, which was founded by King Frederick II. although the revival of its honours and dignities may be dated from this period, when it seemed to be again founded under the auspices of Christian IV. Meursius and his family left Leyden in the year 1635. On his arrival at Sora, he was received with the most friendly tokens of regard by his Majesty and the Danish nobility, and more particularly by Chancellor Rosenkrantz, on whom he has bestowed very ample praises in one of his letters. Here he resided, equally beloved and admired, for above twelve years. His pupils were not very numerous, but his exertions never relaxed. Those hours likewise which were not devoted to the duties of his professorship, he employed in revising the works of the ancients, and in philological disquisitions.

His health was not much impaired by the intensity of application; but in the year 1638 he had a violent attack of the stone, from which disorder he had

Meursius. had suffered severely before. In a letter to Vossius he thus describes his melancholy condition: "The state of my health during the whole of the last winter has been truly deplorable. My sufferings from the stone have been really dreadful. I have voided so many, that the repeated discharges brought on a wound which emitted blood for above four months. I was next attacked by a tertian fever, which increased constantly, and produced an universal lassitude of body, a dejection of spirits, and a total loss of appetite. But, thank heaven, I have now in some measure recovered my strength, and gotten the better of these complaints." He recovered from this attack; but in the following year the disorder returned with redoubled violence, and brought on a consumption which terminated his existence on the 20th day of September 1639. He left behind him a son who was named after him, and one daughter.

So mild were the dispositions of Meursius, that in all his writings he constantly avoided literary disputes. He was sometimes unavoidably drawn into them; but constantly endeavoured to promote a reconciliation, rather than widen any breach, by his replies to the attacks of his adversaries. In his friendships he was firm and affectionate. Of his domestic life, whatever is known has been gathered from his letters. The same easy tranquillity seems to have attended him in every situation. In his family he was particularly fortunate. In his son, to whom he gave his own name, he seemed to behold his own youth renewed. The same application, the same eagerness in the pursuit of knowledge, marked the conduct of this promising young man; who did not long survive his father, but died soon after he had recommended himself to the notice of the learned world by his publications. They were only three in number; but displayed so much solid learning, that they have been assigned to the father, John Meursius, by Labbe Beughem and others. This mistake was occasioned as much by the similitude of their names, as by the nature of their works, and their manner of treating philological subjects.

His works may be divided into four classes, of which each might form a separate volume if they were ever to be republished. Meursius himself indeed, in one of his letters to Vossius, proposes such a division. From that epistle, and from another which the younger Meursius sent to G. I. Vossius, who strongly advised him to republish the whole of his father's writings, and from the collections of his posthumous works which have appeared from Struvius, Groschupsius, Moller, and some others, a catalogue of his works might be formed. Some assistance will also be derived from the indexes published in their respective works, by Hankins, Desselius, Wettenius, and Bartholinus. The plan which Meursius recommends for publishing his works, is to insert in the first volume all that he has written relative to Athens; in the second, his historical pieces; in the third, his miscellaneous dissertations; and in the fourth, the various authors which he published, with his notes and corrections.

Before we conclude, one mistake with respect to this great scholar, which prevails very generally, must be corrected. A scandalous and indecent work, which is intitled *Meursii elegantiae Latini sermonis*, and has *Aloisia Sigee Satyra Sotadica* annexed to it, is very

falsely attributed to Meursius; nor indeed are the *Satires* with more reason assigned to Aloisia Sigee, who was a Spanish lady eminent for her piety and virtue. The real author of these infamous productions was Westrenius, an advocate at Copenhagen, who probably assumed the name of Meursius, in order to shield himself from the disgrace which would naturally have attended the writer of such a performance. To insure the sale of his book, however, might have been the principal view of Westrenius. At any rate, such a conclusion may be fairly deduced from the disguised title, and from his desire that the world should affix it to a character so distinguished and respectable in almost every branch of various literature.

MEW, SEA-MEW, or *Sea-mall*. See LARUS.

Winter-MEW, or *Coddy-moddy*, in ornithology. See LARUS.

MEWING, the falling off or change of hair, feathers, skin, horns, or other parts of animals, which happens in some annually, in others only at certain stages of their lives: but the generality of beasts mew in the spring. An old hart casts his horns sooner than a young one, which is commonly in the months of February and March, after which they begin to button in March or April: and as the sun grows strong, and the season of the year puts forth the fruits of the earth, so their heads grow, and are summed full by the middle of June. It is to be observed, that if a hart be gelt before he has a head, he will never have any; and if he be gelt after he has a head, he will never cast his horns; again, if he be gelt when he has a velvet-head, it will always be so, without fraying or burnishing.

MEXICO, a province of the Spanish empire in America, once a celebrated kingdom, the most powerful and civilized in the New World.

In former times the country now distinguished by the name of the *Vale of Mexico*, was called *Anahuac*, the rest of it being divided into the kingdoms of *Mexico*, *Acolhuacan*, *Tlacopan*, and *Michuacan*; the republics of *Tlaxcallan*, *Cholollan*, *Huexotzinco*, and some other states. Of these the most westerly was Michuacan, which to the east and south had Mexico; on the north the country of the Chichemecas, and some other barbarous nations; on the west the lake of Chapallan, and some independent tribes. It had four considerable cities; the capital being seated on the eastern shore of a beautiful lake named *Pazcuaro*. The kingdom of Tlacopan lay betwixt Mexico and Michuacan, and was of very small extent; its capital was seated on the western border of a lake called *Tezcucuo*, four miles westward of that of Mexico. Acolhuacan was the most extensive as well as the most ancient. It was bounded on the east by the republic of Tlaxcallan; on the south by a province of Mexico named Chalco; on the north by the country of the Huastecas; and on the west by other states of Mexico, terminating at the lake Tezcucuo. Its length from south to north was somewhat more than 200 miles, and its breadth about 60; it was very populous, and had a great many cities. On the eastern bank of the lake of Tezcucuo was situated the capital of that territory, 15 miles to the eastward of that of Mexico; and no less celebrated for its antiquity than the politeness and civilization of its inhabitants. Tlaxcallan, or Tlascala, a celebrated republic, had Acolhuacan to the west;

Mew
||
Mexico.

Kingdoms
into which
Mexico was
anciently
divided.

¹ Mexico. the republics of Cholollan and Huexotzinco to the south; and some of the Mexican states on the north and east. It was but of small extent; not reaching more than 50 miles in length and 30 in breadth. Its capital stood on the side of a great mountain, about 70 miles to the eastward of Mexico. The kingdom of Mexico, though the most modern, came at last to be the most extensive of the whole. On the south and south-west it extended as far as the Pacific Ocean; on the east it was bounded by the republics of Tlaxcopan and Michuacan; on the north by the country of the Huextacas; and on the north-west by the country of the Chichemecas; the whole being comprehended between the 14th and 21st degrees of north latitude, and between 271 and 283 of longitude, computed from the meridian of Ferro.

² Uncertainty of the origin of the Mexicans.

If the origin of the nations on the eastern continent is obscure, that of the inhabitants of the western continent is much more so; and indeed, till very lately, the history of every one of the American nations, till the arrival of the Spaniards, has been either treated as entirely fabulous, or very slightly touched upon by historians. By the industry of the Abbé Francesco Clavigero, however, we are now furnished with an account of the ancient kingdoms just enumerated; more full and authentic than could have been expected, considering the difficulty there must have been of procuring materials.

³ They came from the north.

According to this gentleman, it is undeniable that Mexico was first peopled from the more northerly parts of the continent, which for many ages had been filled with inhabitants. Some have supposed, from the traditions of the natives, and the discovery of very large human skeletons in many parts of New Spain, that this country was first inhabited by giants: but though similar conjectures and discoveries have been made in other countries, we are by no means warranted from thence to conclude that the whole human race were formerly of an immense size; it being most probable, as our author observes, that the gigantic race were but a few individuals who lived at different times and in different nations.

⁴ Toltecas the first inhabitants.

The Toltecas are the most ancient Mexican nation of which we know any thing. They were expelled, as we are told, from their own country (supposed by Clavigero to have been *Tollan*, to the northward of Mexico) in the year 472; and for some time led a migratory and wandering life. In whatever place they determined to reside for any considerable time, they erected houses and cultivated the ground. Thus their migrations were extremely slow, and it was not till 104 years after they set out that they reached a place about 50 miles to the eastward of the city of Mexico, where they settled for 20 years, giving to their new place of residence the name of *Tollantzinco*. From thence they proceeded about 40 miles farther to the west, where they built a city called, from the name of their country, *Tollan*, or *Tula*.

⁵ Their history.

The Toltecas, during their journeys, were conducted by a number of chiefs; who, by the time they arrived at *Tollantzinco*, were reduced to seven, and, after their final settlement, the government was changed into a monarchy; but by what means, or on what account, we are not told. Their first king began his reign in 667, and their monarchy lasted 384 years,

during which time they reckon just eight princes. We are not, however, to imagine that each of their kings lived long enough to make up this space. It was a custom among them that the name of the king should be continued for 52 years, and no longer, from the time he ascended the throne. If he died within that period, the government was carried on in his name by a regency; if he survived, he was obliged to resign his authority. During the four centuries that the Toltecan monarchy continued, they had increased very considerably in number, and had built many cities; but when in the height of prosperity, almost the whole nation was destroyed by a famine occasioned by drought; and a pestilence, probably the consequence of the former. "According to Torquemada (says our author), at a certain festival-ball made by the *Toltecas*, the *sad looking* devil appeared to them of a gigantic size, with immense arms, and in the midst of the entertainment he embraced and suffocated them; that then he appeared in the form of a child with a putrid head, and brought the plague; and, finally, at the persuasion of the same devil, they abandoned the country of *Tula*."

These stories, according to Clavigero, are taken from the symbolical representations or hieroglyphics, by which this piece of history was represented, and which the Spanish author has taken literally. Be the cause what it will, however, it is certain that the surviving Toltecas abandoned their country, and dispersed themselves among the surrounding nations, where they were well received, on account of their superior knowledge and civilization. They were succeeded by the Chichemecas, a much more barbarous people, who came from an unknown country called *Amaquemecan*, where they had for a long time resided; but of which no traces or remembrance can be found among any of the American nations known to Europeans; so that Clavigero supposes it must have been very far to the northward.

The motive which the Chichemecas had for leaving their own country is not known. They were eighteen months on their journey, and took possession of the desolate country of the Toltecas about an hundred years after the former had left it. They were much more uncivilized than the Toltecas; but, however, had a regular form of monarchical government, and in other respects were less disgusting in their manners than some of the neighbouring nations. The last king who reigned in *Amaquemecan* before the departure of the Chichemecas, had left his dominions between his two sons *Auchcauhtli* and *Xolotl*, and the latter conducted the new colony. Having proceeded from the ruins of *Tula* towards *Chempoalla* and *Tepepolio*, *Xolotl* sent his son to survey the country. The prince crossed the borders of the lakes and the mountains which surround the vale of Mexico; then ascending to the top of a very high one, he viewed the whole country, and took possession of it in the name of his father, by shooting four arrows to the four winds.

⁷ Xolotl being informed by his son of the nature of the country, chose for the capital of his kingdom *Tepepolio*, about six miles to the northward of the city of Mexico, and distributed his people in the neighbouring territory; but as most of them went to the northward, that part obtained the name of the country.

⁷ Mexico. try of the Chichimecas, in distinction from the rest. Here a review of the people was taken, and their number, according to Torquemada, was more than a million. In confirmation of this the historian adds, that in his time there were still remaining twelve piles of the stones they threw to ascertain their numbers; but Clavigero thinks it improbable that so large an army should set out on so long an expedition, or that so small a district could maintain so many hunters.

⁸ His people civilized by the Tolte-
cans. Xolotl finding himself peacefully settled in his new dominion, sent one of his officers to explore the sources of some of the rivers of the country. While performing this task he came to the habitations of some Toltecas, who it seems had still kept together, and were likely once more to become a nation. As these people were not inclined to war, and greatly esteemed for their knowledge and skill in the arts, the Chichimecas entered into a strict alliance with them, and Prince Nopaltzin, who had first surveyed the country, married a Toltecan princess. The consequence of this alliance was the introduction of the arts and knowledge of the Toltecas among the Chichimecas. Till now the latter had subsisted entirely by hunting, and such fruits and roots as the earth spontaneously produced. They were clad in the skins of wild beasts, and, like these beasts, they are said to have sucked the blood of the animals they caught; but after their connection with the Toltecas they began to sow corn, to learn the art of digging and working metals, to cut stones, manufacture cotton, and, in every respect, to make great improvements.

⁹ New inhabitants arrive and obtain settlements. When Xolotl had reigned about eight years in his new territories, an embassy of six persons arrived from a distant country not far from *Amaquemecan*, expressing a desire of coming with their people to reside in the country of the Chichimecas. The king gave them a gracious reception, and assigned them a district; and, in a few years after, three other princes, with a great army of Acolhuans, who were likewise neighbours of *Amaquemecan*, made their appearance. The king was at that time at Tezcuco, to which place he had removed his court; and here he was accosted by the princes, who, in a submissive and flattering manner, requested him to allow them a place in his happy country, where the people enjoyed such an excellent government. Xolotl not only gave them a favourable reception, but offered them his two daughters in marriage, expressing his concern that he had no more, that none might have been excluded from the royal alliance. On the third prince, however, he bestowed a noble virgin of Chalco, in whom the Toltecan and Chichimecan blood were united. The nuptials were celebrated with extraordinary pomp; and the two nations, after the example of the sovereigns, continued to intermarry. As the Acolhuans were the more civilized nation of the two, the name of Chichimecas began to be appropriated to the more rude and barbarous part, who preferred hunting to agriculture, or who chose a life of savage liberty in the mountains to the restraints of social laws. These barbarians associated with the Otomies, another savage nation who lived to the northward, occupying a tract of more than three hundred miles in extent; and by their descendants the Spaniards were harassed for many years after the conquest of Mexico.

As soon as the nuptial rejoicings were over, Xolotl divided his territories into three parts, assigning one to each of the princes. Acolhuatzin, who had married his eldest daughter, had Azcopazalco, 18 miles to the westward of Tezcuco; Chiconquauhtli, who married the other, had a territory named Xaltocan; and Tzontecomatl, who married the lady of inferior rank, had one named Coatlichan. The country continued for some time to flourish, population increased greatly, and with it the civilization of the people; but as these advanced, the vices of luxury and ambition increased in proportion. Xolotl found himself obliged to treat his subjects with more severity than formerly, and even to put some of them to death. This produced a conspiracy against him, which, however, he had the good fortune to escape; but while he meditated a severe revenge on the conspirators, he was seized with the distemper of which he died, in the fortieth year of his reign, and in a very advanced age. His corpse was adorned with various figures of gold and silver, and placed in a chair made of gum copal and other precious substances, where it remained five days, until the lords summoned to the funeral attended. The body was then burnt, and the ashes deposited in an urn of the hardest stone. This urn was kept exposed in the palace for forty days, during which time the nobility attended with lamentations; after which it was carried to a cave in the neighbourhood, with similar demonstrations of grief.

¹⁰ Division of the dominions of Xolotl. Xolotl was succeeded by his son Nopaltzin, who at the time of his accession is supposed to have been about sixty years of age. In his time, the tranquillity of the kingdom, which had begun to suffer disturbance under his father, underwent much more violent shocks, and civil wars took place. Alcolhuatzin, the only one of the three princes who remained alive, thinking the territory he possessed too narrow, made war upon the lord of a neighbouring province named Tapotzotlan, and deprived him of his territory. Huetzin, son to the late prince Tzontecomatl, lord of Coatlichan, fell in love with the grand-daughter of the queen, a celebrated beauty, but was rivalled by a neighbouring lord, who determined to support his pretensions by force of arms. Huetzin, however, got the better, defeated and killed his adversary, and then possessed himself of the lady and his estate. This was followed by a rebellion of the whole province of Toltantzincos, so that the king himself was obliged to take the field. As the rebels were very numerous, the royal army was at first defeated; but having at last received a strong reinforcement, the rebels were overcome, and their ringleaders severely punished. The king did not long survive the restoration of tranquillity to his dominions. He died in the thirty-second year of his reign, and ninety-second of his age, leaving the throne to his eldest son Tlotzin.

¹¹ Tlotzin. We are not informed of any particulars relating to this prince farther than he was of an excellent disposition, greatly beloved by his subjects, and, though addicted to peace, yet assiduous in exercising his people in the art of war. He reigned thirty-six years, and died of a very painful disease.

¹² Quinatzin a luxurious prince. Quinatzin, the son and successor of Tlotzin, proved a vain and luxurious prince. His accession to the throne was celebrated with much greater pomp than

Mexico.

any of his predecessors. Xolotl had removed his court from Tenayuca to Tezcuco; but being disgusted with this last place, on account of the conspiracy formed against him there, he had returned to Tenayuca.— There the court continued till the reign of Quinat-zin, who removed it back to Tezcuco. In his passage thither, he caused himself be transported in an open chair or litter, carried on the shoulders of four of his principal lords, while four others held an umbrella over his head. Before his time the kings had been accustomed to walk upon their feet like other people; but this example, once set, was quickly followed by all the lords and great people in the kingdom, who now strove to out-do one another in expensive and ostentatious grandeur.

15
Disturban-
ces in va-
rious parts.

The reign of Quinat-zin, though tranquil at first, was soon disturbed by dangerous revolts and rebellions. These first broke out in two states, named Maztillen and Totopec, situated among the northern mountains. The king, having collected a great army, marched without delay against the rebels, and challenged their leaders to come down and fight him in the plain.— This challenge being accepted, a furious engagement ensued, in which, though great numbers fell on both sides, no decisive advantage was gained by either party. Frequent engagements took place for the space of forty days, until at last the rebels, perceiving that their own numbers were daily diminishing, without any possibility of being recruited like the royal army, made a final surrender to the king, who punished the ringleaders with great severity. Tranquillity, however, was not yet restored: the rebellion spread to such a degree, that the king was obliged not only to take the field in person, but to employ six other armies, under the command of faithful and experienced generals, to reduce the rebels. Those proved so successful in their enterprizes, that in a short time the rebellious cities were reduced to obedience, and the kingdom enjoyed the blessings of peace during the long reign of Quinat-zin, who is said to have sat on the throne for no less than sixty years. He was succeeded by his son Techotlatla; but as the affairs of the Acolhuans now began to be connected with those of the Mexicans, it will be proper to give some account of that people.

16
Migrations
of the Mexi-
cans.

The Mexicans, called also the Aztecas, dwelt till the year 1160 in a country called *Aztlan*, situated to the north of the gulf of California, as appears by the route they pursued in their journey; but how far to the northward we are not certainly informed. Betancourt makes it no less than 2700 miles, and Boturini says it was a province of Asia. The cause of their migration is said to have been as follows:

Among the Aztecas was a person of great authority, named *Huiztilin*, to whose opinion every one paid the utmost deference. He had conceived a design, for what reason we know not, to persuade his countrymen to change their residence; and to effect this he fell upon the following stratagem. Having heard, while meditating on his scheme, a little bird singing on the branches of a tree, the notes of which resembled the word *Tihui*, which in the Azteca language signified "let us go," he took that opportunity to work upon the superstition of the people. With this view, he took along with him a respectable person, and made

him attend to the note of the bird. "What can it mean (says he), but that we must leave this country, and find ourselves another? Without doubt it is the warning of some secret divinity who watches over our welfare: let us obey, therefore, his voice, and not draw his anger upon us by a refusal." Tecpaltzin, for that was the name of his friend, readily agreed to the interpretation; and both of them being persons of great influence, their united persuasions soon gained over to their project the bulk of the nation; and they accordingly set out.

This account, though it has somewhat the air of fable, is what the Mexicans themselves give; and is certainly more worthy of credit than that of the Spaniards, who maintain that the Aztecas set out by the express command of the devil. But whatever was their motive, it is certain that they began their migration about the year above-mentioned. Torquemada says, that in all the hieroglyphic paintings which record this migration, there is delineated an arm of the sea, or a great river, which, however, Clavigero takes to be a representation of the universal deluge. Boturini supposes it to have been the gulf of California, over which, he thinks, they transported themselves; but our author controverts this opinion, because there are no remains of the buildings they constructed, during their migration, in California as there are in other places. If there really was any river of consequence which they crossed, he says it must have been the *Colorado*, or Red River, which discharges itself into the gulf of California, in lat. 32°. 30'. Having crossed this beyond the lat. of 35°, they proceeded towards the south-east, as far as the river *Gila*, where they stopped for some time; and on the banks of that river there are remains of the great edifices they constructed. From thence having resumed their course towards the S.S.E. they proceeded to lat. 29°. and stopped again at a place upwards of 250 miles distant from the city of Chihuahua, towards the N. N. W. This place is now known by the name of *Casa grande*, on account of a very large building still extant, and universally attributed to them by the traditions of the country. It is constructed on the plan of those of New Mexico, that is, consisting of three floors with a terrace above them, and without any entrance to the under floor. The door for entrance opens to the second floor; so that a scaling ladder is necessary: and the inhabitants of New Mexico build in this manner, in order to be less exposed to the attack of their enemies; putting out the scaling ladder only for those to whom they give admission into their houses. No doubt the Aztecas had the same motive for raising their edifice on this plan, as every mark of a fortress is to be observed in it, being defended on one side by a lofty mountain, and the rest surrounded by a wall about seven feet thick, the foundations of which are still existing. In this there are stones as big as mill-stones; the beams of the roof are of pine, and well finished. In the centre is a little artificial mount, apparently constructed with a design to keep guard on, and observe the enemy. Some ditches have been formed in this place, and several kitchen utensils found, as earthen pots, dishes, and jars, with some looking-glasses made of a stone called *itzili*.

The Atzecas having staid here as long as they thought

Mexico.

Mexico. thought proper, crossed the mountains of Tarahumara, directed their course southward, and stopped again for three years at Culiacan, a place situated on the gulf of California, in 24 degrees north latitude. Here they formed a wooden image of a god called *Huitzilopochtli*, whom they imagined to be their tutelar deity, and made a chair of reeds and rushes to transport it, calling this vehicle *the chair of God*. Four priests were chosen, to carry the image on their shoulders, whom they called *the servants of God*; and the act of carrying it they name *teomama*, which signifies "to carry God on one's back."

17
Separation
of the
tribes.

The Aztecas, when they left their original habitations, were divided into six tribes; but here the Mexicans were left with their god by five of them. viz. the Xochimilcas, Tepanecas, Chalcefe, Tlahuicas, and Tlascalans. The cause of this separation is not known. The tribes just mentioned pretend that it was done at the express command of God; but there can be little doubt that it was occasioned by some disagreement among themselves. This is rendered farther probable, when we consider that on their journey towards Tula, the remaining tribe was divided into two violent factions, which alternately persecuted one another: neither did they afterwards construct any more edifices. However, they always travelled together, in order to enjoy the company of their imaginary God. At every place where they stopped an altar was erected to him; and at their departure they left behind them all their sick, and probably also some others to take care of them, or such as were not willing to endure the fatigue of farther journeys. They stopped in Tula nine years, and eleven more in the neighbouring parts. At last, in 1216, they arrived at Zumpanco, a considerable city in the vale of Mexico, where they were received in a very hospitable manner by the lord of that district. He not only assigned them proper habitations, but became very much attached to them; and even demanded from among them a wife for his son Ilhuicatl. This request was complied with; and from this marriage all the Mexican kings descended.

18
The Mexi-
cans per-
secuted,

The Mexicans continued to migrate from one place to another along the lake of Tezcuco. Xoltotl, who was then on the throne of the Acolhuans or Chichimechas, allowed them to settle in whatever places of his dominions they thought proper; but some of them finding themselves harassed by a neighbouring lord, were obliged, in 1245, to retire to Chapoltepec, a mountain on the western borders of the lake, scarce two miles distant from the site of Mexico. This took place in the reign of Nopaltzin; when, as has already been observed, disturbances began to take place in the Acolhuan dominions. The Mexicans, however, did not find themselves any more secure in their new place of residence than formerly: they were persecuted by the neighbouring lords, and obliged to take refuge in a number of small islands, named *Acocolco*, at the southern extremity of the lake of Mexico. Here for 52 years they lived in the most miserable manner that can be imagined; subsisting on fish, insects, roots, &c. and clothing themselves with the leaves of the amoxtli, which abounds in that lake.

19
And en-
slaved.

In this miserable plight the Mexicans continued till the year 1314, when they were all reduced to a state of the most absolute slavery. This was done by

the king of a petty state named Colhuacan: but there are different accounts of the manner in which it was effected. Some say that this prince, unwilling to allow the Mexicans to maintain themselves in his territories without paying tribute, made war upon them, subdued and enslaved them. Others affirm, that, pretending compassion for their miserable situation, he offered them a more commodious place of residence. The Mexicans accepted the offer with great pleasure; but had scarcely set out to take possession of their new place of residence when they were attacked by the Colhuans, made prisoners, and carried off for slaves.

Mexico.

20
After some years a war broke out betwixt the Colhuans and Xochimilcas; in which the latter gained such advantages, that they were obliged to employ their slaves to assist them. They accordingly ordered them to prepare for war, but without furnishing them with arms necessary for a military enterprise; so that the Mexicans were obliged to content themselves with long staves, having their points hardened in the fire: they also made knives of the stone *itztli*, and shields of reeds woven together. They agreed among themselves not to waste their time, as was usual, in making prisoners, but to content themselves with cutting off one ear of their enemies, and then leaving them without farther injury. They adhered punctually to this resolution; and rushing furiously upon the Xochimilcas, cut off an ear from as many as they could, killing those who struggled to such a degree that they could not effect their purpose. In short, so well did the Mexicans acquit themselves in this engagement, that the Xochimilcas not only abandoned the field, but were obliged to take refuge among the mountains. After the battle, the Colhuan soldiers presented themselves before their general with the prisoners they had taken; for it was by the number of these, not of the enemy left dead on the field, that they judged of their valour. The Mexicans had taken only four, and these they kept concealed for the abominable purpose of sacrificing them. The Colhuans, therefore, seeing no trophies of their valour, began to reproach them with cowardice; but the Mexicans, producing their baskets of ears, desired them to judge from these how many prisoners they might have taken, had they not been unwilling to retard their victory by taking up time in binding them.

They re-
gain their
liberty in
in conse-
quence of
a monstrous
piece of
cruelty.

Notwithstanding the valour displayed by the Mexicans in this engagement, it doth not appear that their haughty masters were in the least mollified or inclined to afford them easier terms than before. Having erected an altar to their god, they demanded of their lord something precious to offer in sacrifice to him; but he in disdain sent them a dirty cloth, inclosing the filthy carcase of a vile bird. This was carried by Colhuan priests; and without any ceremony laid upon the altar. The Mexicans, with apparent unconcern, removed this filthy offering, and put in its place a knife made of *itztli*, and an odoriferous herb. On the day of consecration, the Colhuan prince failed not to attend with his nobility; nor with a view to do honour to the festival, but to make a mockery of the Mexicans. Their derision, however, was soon changed into horror, when the Mexicans, after a solemn dance, brought forth the four Xochimilcan prisoners they had taken; and, after having made them dance a little, cut open their

21
The first
human sa-
crifice in
Mexico.

²² Mexico. their breasts with the knife which lay on the altar, and plucking out their hearts, offered them, while yet warm and palpitating with life, to their diabolical idol. This horrible sacrifice had such an effect upon the spectators, that both king and subjects desired the Mexicans immediately to quit their territories and go where they pleased. This order was instantly obeyed: the whole nation took their rout towards the north, until they came to a place named *Acatzitzintlan*, situated betwixt two lakes, and afterwards named *Mexicatzinco*; but for some reason or other, being discontented with this situation, as indeed they seem very often to have been, they proceeded to *Iztacalco*, still nearer to the site of Mexico. Here they formed the image of a little mountain of paper, and danced round it a whole night, singing their victory over the Xochimilcas, and returning thanks to their god for having freed them from the yoke of the Colhuas. Clavigero is of opinion, that by this mountain they represented Colhuacan, as in their pictures it was always represented by a hunch-backed mountain; and this is the literal signification of the name.

²² They settle at last on the islands on which Mexico was built.

Having staid two years in *Iztacalco*, they came to a place on the lake where they found a nopal or opuntia growing in a stone, and over it the foot of an eagle. All the Mexican historians say that this was the mark given them by their oracle of the place where they were finally to settle. Here, then, they put an end to their wanderings; and, as soon as they had taken possession of the spot, an altar was erected to the god, or rather devil, whom they worshipped. The altar was consecrated in a manner conformable to the cruel religion which these people had adopted. Having at that time no prisoners among them, one of their number went out in quest of some animal for a victim; but happening to meet with a Colhuan, a quarrel ensued; and the Mexican proving victorious, bound his enemy, brought him home, and presented his heart to the idol. Around this altar they now began to build their habitations; which, like the celebrated city of Rome, consisted at first of a parcel of miserable rush huts; as they were then furnished with no better materials. Their city, if such it might be called, was named *Tenochtitlan*, and afterwards *Mexico*, which name afterwards prevailed; and, according to Clavigero, signifies the place of *Mexitli* or *Huitzilopochtli*, their god of war: and in this respect also the founding of Mexico was similar to that of Rome, the latter being protected by *Mars* their god of war, as the Mexicans were by *Mexitli*.

²³ Their miserable situation at first.

The city of Mexico was founded in the year 1325, in the most incommodious situation we can imagine, viz on a small island named *Tenochtitlan*, in the middle of a great lake, without ground to cultivate for their subsistence, or even room sufficient to build their habitations. Their life was therefore as miserable here for some time as it had been when they were on the islands at the end of the lake, and they were reduced to the same shifts to maintain themselves. To enlarge the boundaries of their island, they drove palisades into those parts of the water which were most shallow, terracing them with stones and turf, and uniting to their principal island several other smaller ones which lay in the neighbourhood. To procure to themselves afterwards stones, wood, &c. for constructing their

habitations, as well as clothing and other necessities, they instituted a commerce with the people who dwelt on the borders of the lake, supplying them with fish, water-fowl, and other more minute inhabitants of the lake and marshes, which they contrived to render eatable; and in return for all this they received the necessities above-mentioned. The greatest effort of their industry, however, was the construction of floating gardens, by means of bushes and mud of the lake; and these they brought to such perfection that they produced maize, pepper, chia, French beans, and gourds.

For thirteen years that the Mexicans had to struggle with extreme difficulty, they remained at peace; but no sooner did they begin to prosper and live comfortably, than the inveterate enmity betwixt the two factions formerly mentioned broke out in all its fury. This produced a separation; and one of the parties took up their residence on a small island at a little distance to the northward, which, from an heap of sand found there, they at first named *Xaltitlco*, but afterwards *Tlatelolco*, from a terrace constructed by themselves. This island was afterwards united to that of *Tenochtitlan*.

About this time the Mexicans divided their city into four parts, a division which still subsists; each quarter having now its tutelar saint, as it had formerly its tutelar god. In the midst of their city was the sanctuary of their great god *Mexitli*, whom they constantly preferred to all the rest. To him they daily performed acts of adoration: but instead of making any progress in humanity, they seem to have daily improved in the most horrible barbarities, at least in their religion. The dreadful sacrifices made of their prisoners already mentioned, could only be exceeded by that which we are now about to relate. Being now on a more respectable footing than formerly, they sent an embassy to the petty king of Colhuacan, requesting him to send them one of his daughters, that she might be consecrated the mother of their protecting god. The unsuspecting prince, intoxicated with the thoughts of having his daughter made a goddess, readily complied with their desire. The unfortunate princess was conducted in great triumph to Mexico; but no sooner was she arrived, than she was sacrificed in the shocking manner above related; and, to add to the horror of the deed, the body was flayed, and one of the bravest young men of the nation dressed in her skin. Her father, ignorant of this dreadful transaction, was invited by the Mexicans to be present at the apotheosis of his daughter, and went to see the solemnity, and to worship the new divinity. He was led into the sanctuary, where the young man stood clothed in the bloody skin of his daughter; but the darkness of the place prevented him from seeing what was before him. They gave him a censor in his hand, and some copal to begin his worship; but having discovered by the flame of the copal the horrible spectacle, he ran out in a distracted manner, calling upon his people to revenge the injury; but this they were not able to do at that time nor ever after. Historians are unanimous, that this sacrifice was performed at the express command of the devil; and indeed in this instance, their credulity seems pardonable; though Clavigero, with more reason, ascribes it to his priests.

Mexico.

²⁴ The two factions separate.

²⁵ Monstrous barbarity of their religion.

In

Mexico.

Mexico.

26
Acamapitzin the first king of Mexico.

In the year 1352 the Mexican government was changed from an aristocracy to a monarchy. At first they were governed by 20 lords, of whom one had an authority superior to the rest. This naturally suggested the idea of monarchy; and to this change they were also induced by the contemptible state in which their nation still continued, thinking that the royal dignity would confer upon it a degree of splendor which otherwise it could not enjoy; and that by having one leader, they would be better able to oppose their enemies. Proceeding, therefore, to elect a king, the choice fell upon Acamapitzin, a man of great estimation among them, and descended from Opochtli a noble Atzecan, and a prince of the royal family of Colhuacan. As he was yet a bachelor, they attempted to negotiate a marriage, first with the daughter of the lord of Tacuba, and then of the king of Azcapozalco: but these proposals being rejected with disdain, they applied to Acolmiztli lord of Coatlichan, and a descendant of one of the three Acolhuan princes; who complied with their request, and the nuptials were celebrated with great rejoicings.

27
The Tlatelolcos also choose a king.

In the meantime, the Tlatelolcos, the natural rivals of the Mexicans, resolved not to be behind them in any thing which had the least appearance of augmenting the glory of their state. They likewise, therefore, chose a king; but not thinking proper to choose him from among themselves, they applied to the king of the Tepanecas, who readily sent them his son; and he was crowned first king of Tlatelolco in 1353. In this the Tlatelolcos seem to have had a design of humbling their rivals, as well as rendering themselves more respectable; and therefore it is probable, that they had represented the Mexicans as wanting in that respect due to the Tepanecan monarch, as having elected a king without his leave, though at the same time they were tributaries to him. The consequence of this was, that he took a resolution to double their tribute. Hitherto they had paid only a certain number of fish and waterfowl; but now they were ordered to bring also several thousands of fir and willow plants to be set in the roads and gardens of Azcapozalco, and to transport to the court a great floating garden, which produced vegetables of every kind known in Anahuac. This being accomplished with great difficulty, the king commanded them next year to bring him another garden, with a duck and swan in it both sitting upon eggs; but so, that on their arrival at Azcapozalco the brood might be ready to hatch. This was also done; and the prince had the satisfaction of seeing the young birds come out of the eggs. The third year they were ordered to bring a live stag along with a garden. This was more difficult than any of the former tasks; because they were obliged, in order to hunt the stag, to go to the mountains of the continent, where they were in danger of falling into the hands of their enemies; however, this also was accomplished, and the desire of the king gratified.

28
Mexicans oppressed.

In this manner the Mexicans were oppressed for no less than 50 years. They freed themselves, however, from all their difficulties by vigorous exertions, absurdly ascribing to the protection of that malevolent being whom they worshipped the glory of every deliverance. Acamapitzin governed this city, which

at that time comprehended the whole of his dominions, for 37 years in peace. His queen being barren, he married another wife, but without abandoning the first; and these two, instead of being rivals to one another, lived together in the utmost harmony; the first wife taking upon herself the charge of educating *Huitzilihuitl*, the son of the second. He had, besides, several children by other women, and one named *Itzcoatl*, who afterwards proved one of the best and most renowned kings who sat on the throne of Mexico. He is said also to have conquered four considerable cities; but Clavigero thinks he must in this only have been an auxiliary, it being very improbable, that while he could scarce maintain his own territories, he should think of foreign conquests.

Acamapitzin died in 1389, greatly lamented by the Mexicans, and his death was followed by an interregnum of four months. As the deceased monarch had formally resigned his authority into the hands of his nobles, it was necessary that a new election should take place; and when this was done, the choice fell upon *Huitzilihuitl*, the son of Acamapitzin. As he was still unmarried, it was resolved, if possible, to procure him an honourable and advantageous match. With this view, a deputation of nobility was sent to the king of Azcapozalco, requesting, in very humble terms, an alliance with one of his daughters. The expressions made use of by these ambassadors are said by our author to have been particularly elegant in the Mexican language; but it is difficult to understand how a speech made among a people ignorant of the art of writing could be particularly recorded at the interval of some hundreds of years after. They are as follow: "We beseech you, with the most profound respect, to take compassion on our matter and your servant *Huitzilihuitl*, confined among the thick rushes of the lake.—He is without a wife, and we without a queen.—Vouchsafe, Sir, to part with one of your jewels or most precious feathers. Give us one of your daughters, who may come to reign over us in a country which belongs to you."

29
Huitzilihuitl the second king.

This piece of oratory had such an effect upon the king, that he granted their request, and a Tepanecan princess was conducted in great triumph to Mexico, where the marriage was solemnized with the utmost joy. Though this princess brought him a son the first year of their marriage, the king, in order to strengthen himself by fresh alliances, married also the daughter of another prince, by whom he had *Montezuma Ilhuicamina*, the most celebrated of all the Mexican kings.

30
Marries a daughter of the king of the Tepanecas.

We must now return to the history of the Acolhuans, who at this time were governed by *Techotlala* the son of *Quimatzin*. For 30 years this prince enjoyed an uninterrupted tranquillity. This was interrupted by the revolt of *Tzompan*, prince of *Xaltocan*, and the last of the family of *Chiconquauhli*, one of the three original Acolhuan princes, who had drawn into his conspiracy the sovereigns of six other states. The king, out of respect to the quality of the rebel, offered to pardon him if he would lay down his arms; but *Tzompan*, confident of his strength, rejected the offer with contempt. The king was therefore obliged to send an army against him.

31
Reign of Techotlala king of Acolhuans.

Mexico.

in which the Tepanecans and Mexicans served as auxiliaries. The war lasted only two months; Tzompan was defeated and put to death, along with several others of the principal rebels. The Mexicans, who had behaved with great valour, returned in triumph to their city, while Techotlala took several very prudent measures to strengthen his government, prevent rebellions in future, and to augment the splendor of his throne.

In consequence of the renown acquired in this war by the Mexicans, and the advantages resulting from the alliance with the king of Azcapozalco, that people now began to be held in much higher estimation by their neighbours than before. They extended their commerce, and in consequence of that, came to wear cotton instead of the threads of the wild-palm, which had formerly constituted their whole dress: but this gleam of prosperity was soon overcast, and they had to encounter a more inveterate and formidable enemy than any that they had yet met with. This was Maxtlaton prince of Coyoacan, and son to the king of Azcapozalco. Being of a cruel and revengeful temper, for which he was dreaded even by his father, he resolved to resent the indignity which he pretended to have been done to him by the marriage of his sister to the king of Mexico. The true cause of his displeasure, however, was his fear that the Tepanecan crown might devolve on his sister's son by Huitziluhuitl; and to prevent this, he took the barbarous method of sending assassins to murder his nephew. The king of Mexico was not then able to resent the injury; for though, by his marriage with the Tepanecan princess, the oppressive tribute was taken off, and the Mexicans had only to pay a couple of ducks annually, by way of acknowledging the Tepanecan superiority, yet the one nation was far from being in a condition to cope with the other.—The barbarity of Maxtlaton was not unknown to his father; but it is certain that he did not resent it; and indeed there is great reason to suppose that he took part with his son in most of his wicked enterprises.

As the Mexicans advanced in wealth and power, so did their rivals the inhabitants of Tlatlelolco.—Their first king died in 1399, leaving his subjects greatly improved in civilization, and the city much enlarged and beautified. The rivalry which subsisted between the two cities had indeed greatly contributed to the aggrandizement of both. The Mexicans had formed so many alliances by marriage with the neighbouring nations, had so much improved their agriculture, and floating gardens on the lake, and had built so many more vessels to supply their extended commerce and fishing, that they were enabled to celebrate their secular year, answering to A. D. 1402, with greater magnificence than they had ever done since they left their original country of Atztlan.

33
Unfortunate reign of Techotlala's son.

All this time Techotlala continued to reign in Acolhuacan; but being now very far advanced in years, and finding his end approach, he called to him his son Ixtlilxochitl, and recommended to him to beware of the ambitious disposition of the king of Azcapozalco, as he was apprehensive that he might attempt something against the peace of the empire. His suspicions were verified; for on the death of Te-

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chotlala, which happened in 1406, the king of Azcapozalco, without making the usual submissions to the new king, to whom he was a feudatory, set out for his own territories, with a view to stir up the other feudatory princes to rebellion. Having called to him the kings of Mexico and Tlatlelocó, he told them, that Techotlala, who had long tyrannized over that country, being dead, he designed to procure freedom to the princes, so that each might rule his own territory entirely independent of the king of Acolhuacan; but for this purpose he needed their assistance, and trusted to their well known spirit to take part with him in the enterprise. He informed them likewise, that in order to ensure success, he would find means to unite other princes in the confederacy.

The new king of Acolhuacan, in the mean time, was employed in settling the affairs of his kingdom, and endeavouring to gain the good will of his subjects. The combination against him was soon discovered: but though Ixtlilxochitl was desirous of heading his army in person, he was dissuaded from so doing by his courtiers; so that the conduct of the war was committed to his generals. To weaken the enemy, they ravaged the territories of six revolted states; but notwithstanding this, and the superior discipline of the royal army, the war was carried on by the rebels with great obstinacy, their armies being constantly recruited by fresh troops in proportion to their losses. At last, after three years of a ruinous war, the king of Azcapozalco, finding that his resources would at last fail him, sued for peace; but with a design of accomplishing by treachery what he had not yet been able to do by force. His adversary, equally reduced with himself, consented to a peace, though he knew very well that the Tepanecan prince intended to observe it no longer than suited his purpose.

In the year 1409 died Huitziluhuitl king of Mexico, who likewise left the right of electing a successor to the nobility. They made choice of his brother Chimalpopoca; and from thence it became an established law to choose one of the brothers of the deceased king, or if he had no brothers to elect one of his grandsons. While the new prince was endeavouring to secure himself on the throne, the treacherous Tezozomoc used all means in his power to strengthen the party he had formed against the king of Acolhuacan. In this he was attended with such success, that the unfortunate prince found himself reduced to the necessity of wandering among the neighbouring mountains, at the head of a small army, accompanied by the lords of Huexolta and Coatlichan, who remained always faithful to him. The Tepanecans distressed him to such a degree, by intercepting his provisions, that he was forced to beg them of his enemies. One of his grandsons was sent to Otompan, a rebel state, to request them to supply their king with the provisions he stood in need of, and to exhort them to abandon the cause of the rebels, which they had espoused. No task could be more dangerous; yet such was the magnanimity of the young prince's disposition, that he readily set out on the journey; nor was he deterred by the information he got that there were in the place certain Tepanecans who had come on purpose to publish a proclamation from Tezozomoc. He went boldly to the most public place of the town, and in presence of those

Mexico.

34
Chimalpopoca third king of Mexico.

35
Distress and death of the king of Acolhuacan.

who

³⁶ Mexico. who published the proclamation made known his request. This heroism, however, did not meet with the success it deserved. His propositions were derided from the moment they were made; but the people did not offer any farther insult, until one of the meaner sort threw a stone at him, exciting others of the same stamp to put him to death. The Tepanecans, who had hitherto continued silent, perceiving their opportunity, joined in the general cry to kill the prince, and began also to throw stones. The prince attempted first to defend himself, and afterwards to escape by flight; but, both being equally impossible, he fell under a shower of stones. The Tepanecans exulted in this act of treachery, and soon after cut off Ixtlixochitl himself, after having treacherously persuaded him to a conference with two of their captains. This perfidious act was committed in sight of the royal army, who were too weak to revenge it: the royal corpse was saved with difficulty; and *Nezahualcojotl*, heir apparent to the crown, was obliged to shelter himself among the bushes from the fury of his enemies.

³⁶ Acolhuacan conquered by Tezozomoc.

Tezozomoc having now in a great measure gained his point, proceeded to pour down his troops upon those cities and districts which had remained faithful to the late unfortunate monarch. The people made a most desperate defence, and killed vast numbers of their enemies; but at last being themselves reduced by the calamities of war, and in danger of total extermination, they were obliged to quit their habitations and fly to other countries. The tyrant, then, finding himself superior to all his adversaries, gave Tezcuco in fief to Chimalpopoca king of Mexico, Huexotla to Tlacacotl king of Tlatelolco; placing faithful governors in other places, and appointing Azcapozalco, the capital of his own territory, the royal residence and capital of Acolhuacan.

Prince *Nezahualcojotl* was present in disguise at this disposal of his dominions, along with several other persons of distinction who were enemies of the tyrant; and so much was he transported with passion, that it was with difficulty he could be restrained from killing Tezozomoc on the spot, though this would certainly have been done at the expence of his own life. All the rest of the Acolhuacan empire submitted; and *Nezahualcojotl* saw himself for the present deprived of all hopes of obtaining the crown.

³⁷ His tyranny and death.

Tezozomoc had now attained the summit of his ambition: but instead of conciliating the minds of his new subjects, oppressed them with new taxes; and being conscious of the precarious situation in which he stood, and tormented with remorse on account of his crimes, fell into melancholy, and was haunted with frightful dreams. In one, he imagined that *Nezahualcojotl*, transformed into an eagle, had eat out his heart; and in another, that, in the shape of a lion, he licked his body and sucked his blood. Terrified by these visions, he called his three sons, *Tajatzin*, *Teuctzintli*, and *Maxtlaton*, enjoining them to put to death *Nezahualcojotl* as soon as they could get it done without being publicly known. He himself survived his dreams only about a year. He was now become so old, that his body no longer retained its natural heat. He was therefore obliged to be covered up with cotton in a great cradle, not being able to sit

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erect in a chair. In this miserable condition, however, he never forgot his tyranny nor cruelty. From his cradle he issued oppressive laws relating to the Acolhuacans; and almost with his last breath renewed his commands with regard to *Nezahualcojotl*. At last he expired in the year 1422, leaving the crown to his son *Tajatzin*.

Tezozomoc was no sooner dead than *Maxtlaton*, without paying the least regard to his father's will, began to exercise the functions of a sovereign. Though it was the right of *Tajatzin* to invite to his father's funeral whom he pleased, *Maxtlaton* took that upon himself. *Nezahualcojotl*, though not invited, came among the rest; but though *Teuctzintli*, brother to *Maxtlaton*, insisted upon his being put to death, the latter opposed it, as it could not then be done privately, and he hoped to find another opportunity. No sooner were the funeral ceremonies over, however, than *Maxtlaton* behaved in such a manner to his brother *Tajatzin*, that the prince thought proper to retire to *Chimilpopoca* king of Mexico, to whom he had been particularly recommended by his father, in order to have his advice. This monarch, agreeable to the character of that age and people, advised him to invite his brother to an entertainment, and then murder him. Unluckily for them both, this discourse was overheard by a servant, who in expectation of a reward informed the tyrant of what he had heard: but instead of this, *Maxtlaton*, pretending to disbelieve his story, drove the informer from his presence with ignominy. Notwithstanding this pretence, the tyrant had not the least doubt of the truth of what was told him; and therefore determined to rid himself of his brother without delay. This he soon accomplished in the very same way that had been projected against himself. *Tajatzin*, along with the king of Mexico, *Tlatelolco*, and some other feudatory princes, were invited by *Maxtlaton* to an entertainment. The king of Mexico prudently excused himself, but the unsuspecting *Tajatzin* fell into the snare. He came to the place of entertainment, and was instantly put to death. The company were greatly alarmed; but *Maxtlaton*, having explained to them his reasons for so doing, they not only excused him, but proclaimed him king; to which it is not to be doubted that their fears greatly contributed.

Mexico.

³⁸ The throne usurped by *Maxtlaton*.

Though the king of Mexico escaped a sudden death by his absence at this time, it was only to perish in a more slow and ignominious manner. The vengeance of *Maxtlaton* first appeared by sending him a woman's dress in return to the present he sent him as a feudatory; which being a reflection upon his courage, was the highest affront that could be offered him. This insult, however, was quickly followed by one of a much higher nature. Having heard that one of the Mexican princes's wives was an extraordinary beauty, he enjoined some Tepanecan ladies, who were accustomed to visit that princess, to invite her to spend some days with them at *Azcapozalco*. This being complied with, the tyrant easily got an opportunity of ravishing her, and then sent her back to her husband. *Chimilpopoca* was so much affected by this misfortune, that he resolved to offer himself up a sacrifice to his god. *Maxtlaton*, however, was resolved

³⁹ *Tajatzin* murdered.

⁴⁰ Miserable fate of the king of Mexico.

Mexico. that he should not have even this satisfaction. At the very time of the ceremony therefore he sent a body of troops; who entering Mexico without resistance, carried off the king alive, to the astonishment of the multitude; and who probably were so much confounded by this unexpected adventure, that they did not think of making any resistance.

41
He is visit-
ed in pri-
son by Na-
zahualca-
jotl.

Chimilpopoca being carried prisoner to Azcapozalco, was confined in a strong wooden cage, the common prison for criminals. Maxtlaton still was not satisfied: he wished to get into his hands Nezahualcajtli; and with this view sent a message to him, pretending that he was willing to come to an agreement with him respecting the kingdom of Acolhuacan. Though the prince was well assured of the tyrant's treacherous intentions, he went boldly to his palace, presented himself before him, and told him that he had heard of the imprisonment of the king of Mexico; he had heard also that he wished to take away his own life; he desired him to do so, and to gratify his malice. Maxtlaton was so struck with this speech, that he assured the prince he had not formed any design against his life; and that he neither had put to death the king of Mexico, nor would do so. He then gave orders for his being properly entertained, and even allowed him to pay a visit to the king of Mexico in prison. The unfortunate Chimilpopoca, after reciting his misfortunes, requested the prince not to return to court, where they would certainly fall upon some project for taking away his life; and having pathetically recommended to him the care of his subjects, made him a present of a gold pendant and some other jewels he wore; after which they took a last farewell.

42
Adventures
of that
prince.

Chimilpopoca languished in prison for some little time after the departure of Nezahualcajtli; but life became at last so intolerable to him, that he hanged himself in his girdle. His voluntary death, in spite of all that the tyrant had done to prevent it, so exasperated the latter, that he resolved upon the death of the prince at all events, whether in the way recommended by his father or not; to which it is not improbable that he was likewise instigated to this by certain predictions of the priests. He sent out four captains, therefore, with a small party of troops, in quest of the fugitive prince, with orders to kill him as soon as they overtook him. These messengers of death set out directly for Tezcuco, where the prince happened to be at that time playing at foot-ball; for he spent great part of his time in such diversions, that he might remove all suspicions of his aspiring to the throne; and thus he had an opportunity of carrying on his negotiations without molestation. As he knew the errand on which the Tepanecan captains came, he left off his play on their appearance, and retired to his inner apartment. On being informed that they inquired for him, he sent for answer that he would wait upon them after they had reposed and refreshed themselves. The prince made use of this opportunity to quit the house, and retire by a secret door; or, according to Torquemada, by a kind of labyrinth which he had constructed, and through which none but himself knew the way. He then fled to Coatlichan, a small settlement of weavers, who were all exceedingly attached to him. He was pursued thither by the assassins, who had been

informed by a countryman of the road he had taken: Mexico. but such was the inviolable fidelity of the inhabitants, that several of them suffered themselves to be put to death rather than discover the place of his concealment. Leaving this place, therefore, they went thro' the country in quest of him; and no sooner were they gone, than the prince set out in a way directly contrary to that which they had taken. Being pursued in all directions, however, he was in the utmost danger, and would once have been made prisoner if some countrymen had not concealed him under an heap of chia. Having escaped this danger, he went to a pleasant villa at Tezcotzinco, belonging to his ancestors; where he was met by six lords who had left their states. Having consulted with them, it was determined to apply to the Chalcese, although they knew that they were an unfaithful and treacherous people, and had been concerned in the death of the late king. He was then met by ambassadors from the Cholulans, who offered him their assistance against the usurper. In a short time he was joined by numbers of others; so that he was not only no longer in danger of his life, but began to be formidable to his enemies.

In the mean time, the Mexicans, who had suffered many injuries since the death of Chimilpopoca, raised to the throne Itzcoatl, the son of Acamapitzin by a slave, and who was accounted the most prudent, just, and brave, of all the Mexican nation. His election was no less pleasing to Nezahualcajtli and his party, than it was offensive to Maxtlaton. An alliance was quickly concluded between the exiled prince and the king of Mexico; and this was soon followed by the commencement of hostilities on the part of the former. His first enterprise was against the city of Tezcuco, which he determined to take by assault, but was prevented by the submission of the inhabitants. He put to death, however, all the officers established by the tyrant; and all the Tepanecans he found there. The very same day another large city named Acolman was furiously attacked by a detachment of his army; great numbers put to the sword, and among the rest the governor, who was brother to Maxtlaton; and the same day also Coatlichan was taken by the Chalcese.

The Mexican monarch, hearing of the successes of his ally, sent an embassy to congratulate him upon them. His ambassador was a son of king Huitziluhuitl, named Montezuma, who for his invincible courage and great qualities was surnamed the *man of great heart and the archer of heaven*. The journey was extremely dangerous; but Montezuma undertook it without any fear, accompanied by another nobleman. They got in safety to the place where the prince was; but had the misfortune to be taken prisoners, and were carried to Chalco; the lord of which city, named Toteotzin, was an inveterate enemy to the Mexicans. By him he was immediately put in close confinement, under the care of one Quateozin, who was inviolably attached to the Mexican interest. Orders were given to the latter to provide no sustenance for the prisoners but what was prescribed by his lord, until the mode of death which they were to suffer should be determined. Toteotzin then, with a view to flatter the Huexotzincas, sent his prisoners to them, that they might be sacrificed there if they thought proper. These people, however, rejected the proposal with disdain; on which Toteotzin,

43
Itzcoatl raised to the throne of Mexico, who assists Nezahualcajtli.

44
Dangerous embassy undertaken by Montezuma.

Mexico. zin, thinking to regain the favour of Maxtlaton, notwithstanding his treachery in abandoning his cause, informed him of the prisoners he had in his possession. But Maxtlaton (whose character seems not to deserve all the reproaches with which it is loaded) called him a double-minded traitor, and commanded him instantly to set the prisoners at liberty. Before this answer arrived, however, Quateozin had instructed the prisoners how to make their escape, and directed them also not to return by land lest they should again be intercepted, but to embark at a certain place, and proceed by water to Mexico. They followed his advice exactly; and having got to the place to which they were directed, arrived safely at their city, to the great surprise and joy of the inhabitants.

⁴⁵ Maxtlaton declares war against Mexico. Toteotzin, enraged at the loss of his prisoners, put Quateozin to a cruel death, destroying also all his family excepting one son and a daughter; of whom the latter fled to Mexico, where she was highly honoured on her father's account. Maxtlaton, too, notwithstanding his generosity to the prisoners (which Clavigero derives from mere opposition to Toteotzin), prepared to wage a formidable war with the Mexicans, who had agreed to unite their troops with those of the prince. The Mexican populace, terrified at engaging so powerful an enemy, demanded that their king should submit and beg for peace. So great was the tumult, that the king himself was obliged to consent; and it required the utmost exertions of Montezuma's eloquence to persuade the people to agree to a commencement of hostilities. This being done at last, the king next called together the chief nobility, and asked which of them would have the courage to carry an embassy to the king of the Tepanecans? This adventure appeared so hazardous, that all of them kept a deep silence until Montezuma declared himself willing to undertake the arduous enterprise. He was ordered to propose peace to Maxtlaton, but to accept of no dishonourable conditions; to which he punctually adhered. Maxtlaton refused to give any immediate answer, but promised to give one next day, after he had consulted his nobility. Montezuma, dreading some treachery if he staid all night, promised to return next day; which he did, and was told that Maxtlaton had determined upon war. Montezuma then performed the ceremony of challenging him, by presenting him with certain defensive weapons, anointing his head, and fixing feathers upon it, as was customary to do with dead persons. Lastly, he protested, in the name of his master, that as Maxtlaton would not accept of the offered peace, he and all the Tepanecans would infallibly be ruined. Maxtlaton showed not the least sign of displeasure, but gave Montezuma arms in like manner to present to the king of Mexico; and directed him, for his personal security, to return in disguise through a small outlet from the palace. Montezuma followed his advice; but as soon as he found himself out of danger, began to insult the Tepanecan guards; and though they rushed violently upon him, he not only escaped from their attacks, but killed one or two of them.

On his return to Mexico, the populace were again thrown into the utmost consternation by the news that war was inevitable, as the chiefs of the two nations had challenged one another. They now request-

ed the king to allow them to retire from their city, of which they supposed the ruin to be certain. The king encouraged them with the hopes of victory. "But if we are conquered (replied they), what will become of us?" "If that happens (answered the king), we are that moment bound to deliver ourselves into your hands, to be made sacrifices at your pleasure." "Be it so (replied they), if we are conquered; but if we obtain the victory, we and our descendants are bound to be tributary to you; to cultivate your lands and those of your nobles; to build your houses; and to carry for you, when you go to war, your arms and baggage."

⁴⁶ He is defeated and killed. Matters being thus settled, intelligence was sent to prince Nezahualcoyotl to repair with his army to Mexico, which he did without delay; and the day after his arrival a furious engagement took place. The Tepanecan army was commanded by a general named *Mazatl*; Maxtlaton himself not judging it proper to quit his capital. The soldiers on both sides fought with the utmost bravery; but towards night the Mexicans, disheartened by seeing the army of their enemies continually increasing in number, began once more to lose their courage and talk of surrendering. The king, greatly concerned, asked Montezuma what should be done to dissipate the fears of the people? That brave prince replied, that they must fight till death; that if they died with their arms in their hands, it would be honourable; but to survive their defeat, would be eternal ignominy. Nothing could be more salutary than this advice at so critical a juncture: for the Mexicans were already begun to implore the mercy of their enemies, and to promise to sacrifice their chiefs, whose ambition had brought the whole nation into such a dilemma. On hearing this, the whole body of nobility, with the king and Montezuma at their head, assaulted the enemy so furiously, that they repulsed them from a ditch of which they had taken possession; after which, Montezuma, happening to encounter *Mazatl* the Tepanecan general, struck him such a blow on the head that he fell down lifeless. Thus the Mexicans were inspired with fresh courage, and their enemies proportionally dispirited: however, they retired for that night to the city, in some hopes of being able to retrieve their fortune next day. Maxtlaton encouraged them by every method in his power; but fortune proved still more unfavourable than the day before. The Tepanecans were now entirely defeated, and the city of Azcapozalco taken. Maxtlaton, who seems not to have had the courage to fight, had not now the presence of mind to fly. He attempted indeed to hide himself; but being quickly discovered, he was beaten to death with sticks and stones. The city was plundered, the inhabitants butchered, and the houses destroyed by the victors.

⁴⁷ The Tepanecans entirely reduced. This victory proved decisive in favour of the confederates. Every other place of strength in the country was quickly reduced, until the Tepanecans, finding themselves on the verge of destruction, sent an humble embassy to the king of Mexico, requesting to be taken under his protection, and to become tributaries to him. Itzcoatl received them graciously; but threatened them with total extirpation if they violated the fidelity they had sworn to him. Thus the whole Tepanecan nation was subjected to the Mexicans, excepting

Mexico. cepting only the state and city of Cojohuacan, which continued refractory for a considerable time.

Itzcoatl, after this extraordinary success, took care to have the above mentioned contract ratified between the nobility and common people, by which the latter were bound to perpetual services. Those who had discouraged the soldiers in time of battle were banished for ever from the state of Mexico; while Montezuma and others who had distinguished themselves by their bravery, were rewarded with lands, as was usual with other conquerors.

48 **Nezahualcajotl made king of Acolhuacan.** Itzcoatl, now finding himself firmly seated on the throne of Mexico, set about performing his engagements to the Acolhuacan prince, by seating him on the throne of his ancestors. Having again joined their armies, they marched against Huaxotla, a city which refused to submit even though terms of pardon were offered them. Instead of this, they rashly ventured a battle, in which they were entirely defeated; and were then fain to send a deputation of their old men, pregnant women, &c. as was customary in cases of distress, to move the enemy to compassion. At last all obstacles being removed, Nezahualcajotl was seated on the throne of Acolhuacan, the auxiliary troops were dismissed, and Itzcoatl left at liberty to pursue his conquests, in which he was still assisted by the king of Acolhuacan. The first expedition was against Cojohuacan and other two Tepanecan cities, who had not only refused submission themselves, but excited others to shake off the yoke also. The war against them proved bloody. Three battles were fought, in which Itzcoatl gained no other advantage than making the enemy retreat a little; but in the fourth, while the two armies were hotly engaged, Montezuma, with a body of chosen troops, which he had placed in ambuscade, attacked the rear-guard of the rebels with such vigour, that they were soon disordered, and obliged to fly to the city. The conquerors pursued them thither; and Montezuma perceiving that they intended to fortify themselves in the greater temple, frustrated their design by getting possession of it and burning the turret. By this disaster they were so much terrified, that they fled to the mountains south of Cojohuacan; but even there the royal army overtook and pursued them more than 30 miles, till they came to another mountain, where, quite exhausted with fatigue, and seeing no means of escape, they were obliged to surrender at discretion.

49 **Conquests of the Mexicans.** Having thus happily accomplished the conquest of Cojohuacan and the other rebellious cities, the two kings returned to Mexico. Itzcoatl gave great part of the Tepanecan country to *Totoquihuatzin*, with the title of king of *Tacuba*, a grandson of Tezozomoc, but who does not appear to have been any way concerned in his projects against the Mexicans. An alliance was then formed among the three kings on the following terms: The king of Tacuba held his crown on condition of serving the king of Mexico with all his troops, at any time when required; for which he was to have a fifth part of the spoils taken from the enemy. The king of Acolhuacan was likewise to assist the king of Mexico in war; and for this he was to have a third part of the plunder, after deducting the share of the king of Tacuba; and the remainder was to belong to the king of Mexico. The kings of Ta-

50 **Alliance between the kings of Mexico, Acolhuacan, and Tepaneca.**

cuba and Acolhuacan were both declared honorary electors of the kings of Mexico; the real electors being four nobles: and the king of Mexico was likewise bound to assist in the wars of his allies whenever it was demanded.

After having thus settled matters among themselves, and rewarding their soldiers, Itzcoatl set out with Nezahualcajotl for Tezcuco, where the Acolhuacan king was crowned with all possible ceremony. Here the new king took every method which prudence could suggest to establish his authority on a permanent basis; but while he was thus employed, the Xochimilcas, fearing lest the Mexicans might conquer their country as they had done that of the Tepanecans, held a council on what was to be done to prevent such a disgrace. In this council it was determined to commence hostilities against that rising state, before it should become more formidable by new conquests. Itzcoatl was no sooner informed of this determination, than he sent Montezuma with a great army against them. The Xochimilcas met him with one still more numerous; but being worse disciplined, they were quickly defeated, and their city taken in a very short time after. This conquest was followed by the reduction of Cuitlahuac, situated on a small island on the lake of Chalco. Their insular situation gave them confidence to attack the formidable power of the Mexicans. The king was so sensible of the difficulty of this enterprise, that he proposed to attack them with the whole force of the alliance: Montezuma, however, with only a small number of men of his own training, whom he furnished with proper vessels, reduced them in seven days.

These conquests were followed by the reduction of the cities of Quauhnahuac, Quantitlan, and Toltitlan; the first of which was so strong, that Itzcoatl was obliged to call in his allies to his assistance. In short, in the space of twelve years, Mexico, from being a contemptible and tributary state, became able to command those whom it had formerly served, and who thought themselves very much superior in every respect.

Itzcoatl died in the year 1436, at a very advanced age, in the height of prosperity, and was succeeded by Montezuma I. the greatest monarch that ever sat on the Mexican throne. Before his coronation, in order to comply with the barbarous rites of his religion, he made war upon the Chalcese in order to procure the prisoners who were to be sacrificed at his coronation; and scarce was this ceremony over, than a new war commenced, which terminated in the destruction of that city. This quarrel happened between the Chalcese and the Tezcucans. Two of the royal princes of Tezcuco having gone a-hunting on the mountains which overlook the plains of Chalco, while employed in the chase, and separated from their retinue, with only three Mexican lords, fell in with a troop of Chalcese soldiers; who, to gratify the cruelty of their master, carried them all prisoners to Chalco. The cruel and inconsiderate tyrant who commanded there instantly put them all to death; after which he caused their bodies to be salted, dried, and placed in an hall of his palace, where they served as supporters to the pine torches burned there for light every evening. The king of Tezcuco, overwhelmed with

Mexico.

51 **Other conquests.**

52 **Montezuma I. king of Mexico.**

⁵³ ^{Chalco taken.} Mexico. with grief, and to the last degree exasperated at such an inhuman act, called for the assistance of the allied kings. The city was attacked at once by land and water. The inhabitants, knowing that they had no mercy to expect, fought like men in despair. Even the old tyrant who commanded them, though unable to walk, caused himself to be carried in a litter among the combatants; notwithstanding which they were totally defeated, and the most severe vengeance executed upon them.

⁵⁴ ^{Tlateloco reduced, and Moquihuix made king.} Montezuma, on his return, found himself obliged to encounter an enemy more formidable on account of his vicinity, than more powerful ones at a distance. This was the king of Tlatelolco, who had formerly conspired against the life of Itzcoatl; and finding himself disappointed in this, had tried to reduce his power by entering into a confederacy with some of the neighbouring lords. At that time his designs proved abortive, but he resumed them in the time of Montezuma; the consequence of which was, that he was defeated and killed. One *Moquihuix* was chosen in his room; in whose election it is probable that Montezuma had a considerable share. This was followed by conquests of a much more important nature. The province of *Cuibixcas*, lying to the southward, was added to his dominions, comprehending a tract of country more than 150 miles in breadth; then, turning to the westward, he conquered another named *Tzompahacuan*. This success, however, was for a short time interrupted by a war with *Atonaltzin*, lord of a territory in the country of the *Mixtacas*. This prince, puffed up on account of the great wealth he possessed, took it into his head that he would allow no Mexican to travel through his country. Montezuma sent ambassadors to know the reason of such strange conduct; but *Atonaltzin* gave them no other answer than showing them some part of his wealth, making a present to the king, and desiring him from thence to observe how much the subjects of *Atonaltzin* loved him; and that he willingly accepted of war, which was to determine whether he should pay tribute to the Mexicans or the Mexicans to him. Montezuma having informed his allies of this insolent answer, sent a considerable army against *Atonaltzin*, but had the mortification to be informed of its defeat; in consequence of which the pride of *Atonaltzin* was increased to a great degree. Montezuma, greatly chagrined at this first check, determined to head his next army in person; but before he could call together another, *Atonaltzin* had drawn into a confederacy with him the *Huexotzincas* and *Tlascalans*, who were glad of the opportunity, as they supposed, of reducing the power of the Mexicans. Their numbers, however, availed but little; Montezuma in the very first engagement totally defeated the confederate army. The allies of *Atonaltzin* were particularly unfortunate; for such of them as were not killed in the field of battle, were destroyed by their own party out of revenge for the unfortunate event of the battle.

⁵⁵ ^{Atonaltzin defeated, and the Mexican dominions enlarged.}

By this victory the Mexican monarch became master not only of the dominions of *Atonaltzin*, but of many other neighbouring princes, against whom he made war on account of their having put to death some Mexican merchants or couriers without any just

cause. The conquest of *Cuetlachtlan* or *Cotasta*, however, which he attempted in 1457, proved a much more difficult task. This province lies on the coast of the Mexican gulph, and had been formerly inhabited by the *Olmecans*, whom the *Tlascalans* had driven out. The inhabitants were very numerous; but dreading the power of Montezuma, called in those of *Tlascala*, together with the *Huexotzincas*, to their assistance. Along with these the allies drew the *Cholulans* also into the confederacy; so that this appears to have been the most formidable combination that had yet been formed against the Mexican power. Montezuma collected an excellently equipped army; which, however, he did not on this occasion command in person. It contained a great number of persons of very high rank, among whom were three princes of royal blood, and *Moquihuix* king of *Tlatelolco* already mentioned. The combination of the three republics against Mexico was not known at court when the army set out; but Montezuma, being informed of it soon after, sent an order to his generals to return. This accorded so ill with the romantic notions of valour entertained by the Mexicans, that a consultation of the generals was held whether they should obey it or not. At last it was determined that the king's order should be obeyed; but no sooner was this agreed to than *Moquihuix* accused them all of cowardice, and threatened, with his own troops, unassisted, to go and conquer the enemy. His speech had such an effect upon them all, that they went to meet the confederates. The *Cotastese* fought with great valour, but were unable to resist the royal forces; and their allies were almost totally destroyed. Six thousand two hundred of them were taken prisoners, and soon after sacrificed to the Mexican god of war in the barbarous manner already described. The victory was said to have been owing principally to the valour and good conduct of *Moquihuix*, inasmuch that to this day a song made in his praise on that occasion is known in Mexico. Montezuma was so well pleased with the victory, that he not only forgave the disobedience of his orders, but bestowed upon *Moquihuix* a princess, one of his own cousins, to wife.

⁵⁶ ^{Chalcese rebel, and are destroyed.} The next exploit of this great warrior was the entire destruction of the *Chalcese*, whose restless disposition continually brought mischief upon themselves. They had, it seems, formed a design of making their city a rival to Mexico; and with this view had taken prisoner one of the brothers of Montezuma himself, whom they attempted to make their sovereign absolutely against his own inclination. The prince, finding it impossible to resist, pretended to comply with their wishes; but that the act of exalting him to this dignity might be more conspicuous, he desired them to plant in the market-place one of the highest trees, and place a scaffold upon it, from whence every body might see him. This being done, the Mexicans who had been taken along with him assembled round the tree; and the prince having ascended the scaffold with a bunch of flowers in his hand, addressed them to the following purpose: "Ye know well, my brave Mexicans, that the *Chalcese* wish to make me their king; but it is not agreeable to our god that I should betray our native country; I choose rather to teach you, by my example, to place higher value on fidelity to it."

Mexico. it than on life itself." With these words he threw himself from the scaffold, and was killed. The Chalcas were so enraged at this, that they instantly fell upon the Mexicans and killed them with their darts. Next evening they were terrified by a screech-owl; the dismal voice of which animal they interpreted into an omen of their approaching ruin. They were not deceived in their predictions, which indeed they might have made without any screech-owl. They were quickly attacked by Montezuma; who on this occasion was so much exasperated, that he caused fires to be lighted on the tops of the adjacent mountains, as symbols of the punishment to which he condemned the rebels. The havoc he made among them was such, that the province was almost depopulated. Vast numbers were slaughtered, while those who escaped with life fled into the caves of the neighbouring mountains. Some fled into distant countries, leaving their city to be destroyed by the enemy. At last Montezuma, satiated with revenge, proclaimed a general pardon, and invited the fugitives to return; but many of them, not putting any confidence in his sincerity, chose to remain in their state of exile. The remainder of this emperor's reign was taken up in making new conquests; so that by the time of his death, which happened in 1464, he had extended his dominions as far as the gulf of Mexico on the east; to the middle of the country of the Mixtecas on the south-east; something farther than Chilapan on the south; to the valley of Toluca on the west; the centre of the country of the Otomies on the north-west; and, on the north, to the extremity of the vale of Mexico.

57
Inundation
and famine
at Mexico.

During the reign of this great monarch a violent inundation happened in Mexico. The lake, swelled by the excessive rains which fell in the year 1446, poured its waters into the city with so much violence that many houses were destroyed, and the streets inundated to such a degree that boats were every where made use of. To prevent accidents of this kind for the future, Montezuma, by advice of the king of Tezcuco, constructed a great dyke nine miles in length, eleven cubits in breadth, and consisting of two parallel lines of palisades, the interval betwixt which was filled up with stones and sand. The greatest difficulty in the construction lay in being obliged occasionally to work in the lake itself, which in some places was of considerable depth; but this was surmounted by the skill and perseverance of the workmen. The dyke, when constructed, proved of great service in keeping out the waters, though it did not entirely remedy the evil; nor indeed have the Spaniards been able to secure this city effectually from inundations, after being in possession of it for more than two centuries.

The inundation was soon followed by a famine. This was occasioned by the stinting of the crop of maize in 1448; the ears while young and tender being destroyed by frost. In 1450 the crop was totally lost for want of water; and in 1451, besides the unfavourable seasons, there was a scarcity of seed. Hence, in 1452, the necessities of the people became so great, that they were obliged to sell themselves for slaves in order to procure subsistence. Montezuma permitted them to go to other countries for support; but being informed that many sold themselves for a few days provision, he ordered by proclamation, that no wo-

man should sell herself for less than 400 ears of wheat, nor any man for less than 500. He opened also the public granaries for the relief of the lower classes; but nothing was able to stop the progress of the famine. Many who went for relief to other countries perished with hunger on their journey; and great numbers who sold themselves for slaves never returned to their native country. Most of the populace supported themselves, like their ancestors, on the produce of the lake, until all their distresses were relieved by a most plentiful harvest in the year 1454.

Montezuma was succeeded by Axayacatl, who like his predecessor instantly commenced a war, for no other reason than that he might have prisoners to sacrifice at his coronation. The people whom he now attacked inhabited the province of *Tecuan-tepec* on the coast of the Pacific Ocean, and situated at 400 miles distance from the city of Mexico. A very desperate battle ensued on this occasion, in which, however, the Mexicans at last prevailed; and, besides the poor wretches doomed to destruction whom they carried off, acquired a considerable spoil, as well as a tract of territory extending to Coatulco, a maritime place much frequented in the next century by the Spaniards.

Axayacatl pursued Montezuma's plan of conquest; in which, however, he was less successful, many of the provinces reduced by that monarch having revolted after his death, so that it was necessary to reconquer them. On his returning successful from one of these expeditions, he built a new temple, to which he gave the name of *Coatlon*; but the Tlatelolcos, whose ancient rivalry seems to have revived on the death of Montezuma, built another in opposition, which they called *Coaxolotl*. Thus the former hatred between the two nations was renewed, and a discord took place which ended in the ruin of the Tlatelolcos.

The Mexicans sustained an irreparable loss in 1469 and 1470 by the death of their allies the kings of Tacuba and Acolhuacan; for though the league which had been concluded between the three nations continued without any violation till the arrival of the Spaniards, we cannot suppose that any of the successors of the Tacuban and Acolhuacan princes would have the same cordial affection for those of Mexico which was entertained by those who lay under such great obligations to Montezuma. The king of Tacuba was succeeded by his son Chimalpopoca, and the Acolhuan monarch by his son Nezahualpilli. A short time after the accession of the latter, the war broke out between the Tlatelolcos and Mexicans, which ended in the destruction of the former. King Moquihuix had been married by Montezuma to a sister of Axayacatl, now on the throne of Mexico; but it appears that this princess never was greatly the object of his affection. On the contrary, he took all methods of expressing his dislike, either out of enmity to herself, or envy of the superior greatness of her brother. Not content with this, he entered into an alliance with a great number of the neighbouring states, in order to reduce the Mexican greatness. His wife, however, being informed of this scheme, communicated the particulars to her brother; and soon after, being impatient of the ill usage she received, came to Mexico with her four sons to claim the protection of her brother. This

58
Axayacatl
succeeds
Montezuma.

59
His conquests.

60
Death of
the kings
of Acolhuacan and
Tacuba.

Mexico.

61
Tlatelolco
reduced
and the
king kill-
ed.

uncommon accident exasperated the Mexicans and Tlatelolcans against each other to such a degree, that wherever they met, they fought, abused, and murdered each other. The king of Tlatelolco prepared for war with many horrid ceremonies, of which the drinking of human blood was one. A day was appointed for attacking Mexico. Xiloman, lord of Colhuacan, was to begin the attack, afterwards to pretend flight, in order to induce the Mexicans to follow him; after which the Tlatelolcos were to fall upon their rear. For some reason, however, with which we are not acquainted, the Tlatelolcos began the attack without waiting for Xiloman; the consequence of which was, that he retired in disgust, leaving them to finish their battle the best way they could. The engagement lasted till night, when the Tlatelolcos were obliged to retire. Axayacatl, during the night, disposed of his troops in all the roads which led to Tlatelolco, appointing them to meet in the market-place. The Tlatelolcos, finding themselves attacked on all sides, retired gradually before the Mexicans, until at last they were forced into the market-place, where they found themselves worse than ever on account of its narrowness, which did not allow them room to act. The king stood on the top of the great temple, encouraging his men to exert themselves against the enemy. His words, however, had now lost their usual influence. He not only was not obeyed, but was reproached with cowardice because he did not come down and fight among the rest. At last the Mexicans arrived at the temple, and ascended to the balcony where the king was. He made a desperate defence for a little; but by a violent push in the breast was thrown backward upon the steps of the temple, and stunned or perhaps killed by the fall. The soldiers took him up and carried him to Axayacatl; who with his own hand cut open his breast and tore out his heart. His people then attempted to fly across the market-place; but a great number of them were killed, among whom were many officers of distinction. The city of Tlatelolco was then united with Mexico, as a part or kind of suburb, which it still continues to be.

62
Axayacatl
wounded
and in
great dan-
ger.

The Tlatelolcos being thus reduced, Axayacatl next set out on an expedition against the Matlatzincas, a tribe in the vale of Toluca, who still refused to submit to the Mexican yoke. Having proved successful in this expedition, he undertook to subdue also the northern part of the valley, now called *Valle d' Ixtlahuacan*, particularly *Xiquipilco*, a considerable city and state of the Otomies, whose chief was much renowned for strength and bravery. Axayacatl, who likewise valued himself on these qualities, encountered him in single combat. In this, however, he was over-matched, and received a violent wound on the thigh; after which he would have been taken prisoner, had not some young Mexicans made a desperate effort for his rescue. Notwithstanding this disaster, Axayacatl's army gained a complete victory, carrying off 11060 prisoners, among whom was the chief of the Otomies himself, and two of his officers who had attacked the king. These chiefs were put to death at an entertainment of the allied kings, the fight of their agonies not interrupting in the least the mirth of the

feast; so much were they familiarized to the shedding of human blood. Mexico.

Axayacatl continued to extend his territories to the east and west, till his progress was stopped by death in 1477. He was succeeded by his elder brother Tizoc; of whose reign we know little, but that he conquered fourteen cities, some of which had been in rebellion. He intended to have built a larger temple than any that had yet been seen in Mexico, though that originally built had been greatly enlarged by some of his predecessors. For this purpose he collected a great quantity of materials; but before he could bring his projects to bear, he was taken off by a conspiracy of his subjects. We are not informed in what manner he died; most probably it was by poison, as the conspirators wished his death to pass for natural. It being discovered to be otherwise, however, diligent search was made for the criminals, who were punished according to their deserts. During the reign of Tizoc, the Acolhuacans made war upon the Huexotzincas, ruined their city, and conquered their territory. Nezahualpilli also, the Acolhuacan monarch, though he had already several wives, had not made any of them queen, having wished to confer that honour upon one of the royal family of Mexico. Tizoc readily gave him one of his grand-daughters, who had a sister of singular beauty named *Xocotzin*. The friendship betwixt these two ladies was such, that the one could not think of being separated from the other; for which reason the new queen sought and obtained permission to take her sister along with her to Tezcuco. Xocotzin had not been long there before the king fell in love with her, and married her with the title of queen likewise. Soon after this second marriage, the first queen brought forth a son named *Cacamatzin*, who succeeded him in the throne, and was afterwards taken prisoner by the Spaniards.

Ahuitzotl, the brother of Tizoc, succeeded him in the kingdom of Mexico. His first object was to finish the great temple begun by his predecessor; and such was the number of workmen, that it was completed in four years. During the time that it was building, the king employed himself in making war with different nations, reserving all the prisoners he took for victims at the dedication of the temple. The number of prisoners sacrificed at this dedication is said by Torquemada to have been 72,324; by other historians 64,060. The miserable victims were ranged in two files, each a mile and an half in length, terminating at the temple. The same year another temple was built by a feudatory lord, in imitation of the great one built by the king; at the dedication of which a vast number of prisoners were also sacrificed. These temples were dedicated in 1486. In 1487 happened a violent earthquake; and Chimalpopoca king of Acolhuacan died, who was succeeded by Totoquihuatzin II.

The remainder of the life of Ahuitzotl was a continued series of wars, in all of which he proved ultimately successful, extending the Mexican dominions as far as Guatemala, 900 miles to the south-east of Mexico. In only one expedition the Mexicans were defeated with disgrace. This happened in 1496, when they suddenly, and as appears without any provocation, entered the vale of Atlixco in an hostile manner.

63

Is succeed-
ed by Ti-
zoc.

64

Ahuitzotl
dedicates
a temple
with a mul-
titude of
human vic-
tims.

65

His con-
quests.

Mexico.

manner. So unexpected was the invasion, that the inhabitants of Atlixco knew only of the intention of their enemies by seeing them in arms in their country. Finding it impossible to raise in an instant a sufficient force among themselves, they applied to their neighbours, the Huexotzincas. On their arrival at the city, which it seems had already been rebuilt since its destruction by the Acolhuacans, they found a most celebrated captain, named Toltecatl, amusing himself at foot-ball. Being informed of the arrival of the Mexican army, he instantly quitted his diversion to repair to Atlixco; where, to show his contempt for the enemy, he entered the battle unarmed.—He supplied himself with armour by knocking down the first Mexican he met with his fist, and seizing his armour. He then attacked the enemy with such fury, and was so well seconded by his troops, that the Mexicans were totally defeated; and, in consideration of his signal bravery, the Huexotzincas made him the chief of their republic. He had not continued in his new office more than a year, however, when, finding himself unqualified for being legislator to such turbulent subjects as he had to deal with, he quitted his dignity and his country at once; and crossing the mountains with some other nobles, came to Tlalmanalco, where he was put to death, with all his companions, by order of Ahuizotl.

66

His death.

Ahuizotl died in 1502, of a disorder produced by a contusion in his head. Of the cause of which we have the following account: In 1498, the king, thinking that the navigation of the lake of Mexico was become difficult on account of the scarcity of water, formed a project of supplying the deficiency from a fountain which supplied the Cojoacanese, and called upon the lord of the district to give orders for that purpose. This nobleman represented that the spring was not constant; that sometimes it was dry, and at others ran so abundantly that it might occasion some disaster in his court. Ahuizotl, however, supposing this to be a pretence, renewed his order, and put the nobleman to death for insisting upon his objection. He then caused a spacious aqueduct to be constructed from Cojoacan to Mexico; and the water was brought in with a great many superstitious ceremonies. That very year, however, there fell such quantities of rain, that the waters of the lake, augmented also by those of the spring, overflowed the city, so that the streets were filled with sailing vessels, and some houses were destroyed. The king happening to be one day in a lower apartment of his palace, the waters entered with such rapidity and violence that he was obliged to fly; and the door being low, he struck his head with such force against the top, that he never recovered the effects of the contusion. This inundation was followed by a famine, all the maize being rotted by the water.

67

Montezuma II.

At the time of Ahuizotl's death, the Mexican empire was brought to its utmost extent. His successor, Montezuma Xocojotzin, or Montezuma Junior, was a person of great bravery, besides which he was likewise a priest, and held in great estimation on account of his gravity and the dignity of his deportment. His election was unanimous; and the nobles congratulated themselves on the happiness the country was to enjoy under him, little thinking how short

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the duration of their happiness or of their empire was to be. Mexico.

The first care of the new monarch, as usual, was to procure victims for the barbarous sacrifices to be made at his coronation. The people of Atlixco, who had again shaken off the Mexican yoke, were the sufferers on this occasion, being once more reduced, though not without great loss on the part of the Mexicans, some of whose bravest officers perished in the war. The ceremony of coronation was performed with such pomp as had never been seen before in Mexico; but no sooner was this ceremony over than Montezuma began to discover a pride which nobody had suspected before. All his predecessors had been accustomed to confer offices upon persons of merit, and those who appeared the most able to discharge them, without any partiality as to birth or wealth. Montezuma, however, disapproved of the conduct of his predecessors, under pretence that the plebeians should be employed according to their rank; for that in all their actions the baseness of their birth and the meanness of their education appeared: and in consequence of this maxim he deprived all the commoners of the offices they held about the court, declaring them incapable of holding any for the future. All the royal servants now were people of rank. Besides those who lived in the palace, 600 feudatory lords and nobles came to pay court to him. They passed the whole day in the antichamber, where none of their servants were permitted to enter; conversing in a low voice, and waiting the orders of their sovereign.—The servants of these lords were so numerous that they occupied three small courts of the palace, and many waited in the streets. The women were not less numerous. All these last were confined in one vast seraglio, under the care of some noble duennas, who kept a strict watch over their conduct. From this collection the emperor selected such as he liked best for himself, giving away the rest; and so well did he acquit himself in his matrimonial capacity, that *an hundred and fifty* of his wives are said to have been pregnant at once.

The pride of Montezuma was no less conspicuous in the ceremonials than in the magnificence of his court. None durst enter the palace without pulling off his shoes and stockings at the gate; neither durst they appear pompously dressed in the imperial presence; this being deemed a want of respect to majesty.—All who entered the hall of audience, before speaking to the king, made three bows; at the first, saying *Lord!* at the second, *My Lord!* and at the third, *Great Lord!* They spoke low, and with the head inclined, receiving the answer which the king gave them by secretaries, with as great humility as if it had been the voice of a deity; and no person in taking leave ever turned his back on the throne. When this mighty emperor went abroad, he was carried on the shoulders of the nobility, in a litter covered with a rich canopy, and attended by a numerous retinue of courtiers; and wherever he passed, every person shut their eyes, as fearing to be dazzled with the splendor of Majesty. When he alighted from the litter to walk on foot, carpets were spread on the ground, that the emperor might not be permitted to touch the earth with his feet.

68
His excess-
sive haugh-
tiness.

In

Mexico.

[68]
Magnifi-
cence dis-
played in
his palace.

In every respect Montezuma kept up, as far as was possible, this extravagant appearance of dignity. His kitchen-utensils were of the finest earthen ware, and his table-cloths and napkins of the finest cotton; but none of these ever served the emperor more than once, being immediately made a present of to some nobleman. The vessels in which his chocolate and other drinks from cocoa were prepared, were all of gold, or some beautiful sea-shell, or naturally-formed vessels, curiously varnished. He had also gold-plate, but it was used only on particular occasions in the temple. The number and variety of his dishes astonished the Spaniards. Cortes says, that they covered the floor of a great hall; and that there were dishes of every kind of game, fish, fruit, or herbs, in the country. This dinner was carried in state by three or four hundred of the young nobility, who retired as soon as the king sat down to table: and that the meat might not grow cold, each plate was furnished with a chafing dish. The king marked with a rod the dishes he chose for himself, and the rest were distributed among the nobility in the antichamber. Before he sat down, four of the most beautiful women of his seraglio supplied him with water to wash his hands, and continued standing all the time of his dinner, along with six of his principal ministers and his carvers.

Montezuma took great delight in the cleanliness of his own person, and of every thing about him. He bathed regularly every day, and had baths in all his palaces. Every day he wore four dresses, never using again those which he had put off, but reserving them as largesses for the nobility, or those who had distinguished themselves in war.

69 Dislikes his subjects. The expence of all this, and many other instances of magnificence, rendered the emperor very disagreeable to a great number of his subjects; though others were pleased with the readiness he showed to relieve the necessities of individuals, and his generosity in rewarding his generals and ministers who deserved it. Among other actions worthy of imitation, he appointed the city of Colhuacan as an hospital for all invalids, who after having faithfully served the crown either in the civil or military line, required a provision on account of their age and infirmities. In this place they were maintained and attended at the expence of the king.

70 His unsuccessful war with Tlascala. The reign of Montezuma, even before the arrival of the Spaniards, was far from being so glorious with regard to his successes in war as those of his predecessors had been. He reduced indeed one rebellious province, and conquered another which had never before been subjugated; but in his war with Tlascala he was by no means successful. This was but a small republic at no great distance from the capital, but the inhabitants were remarkable for their bravery and independent spirit. The neighbouring states, however, who had been reduced by the Mexicans, envious of their liberty and prosperity, exasperated the Mexicans against them, by representing that the Tlascalans were desirous of making themselves masters of the maritime provinces on the Mexican gulf, and that by their commerce with these provinces they were encreasing their wealth and power, and gaining the hearts of the people with whom they were to traffic. In consequence of this representation, strong garrisons were placed on the frontiers of Tlascala, to obstruct the commerce of

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the inhabitants, and thus to deprive them of the means of obtaining some of the necessaries of life. The Tlascalans complained; but received no other answer than that the king of Mexico was lord of all the world, and that the Tlascalans must submit and pay tribute to him. The Tlascalans returned a spirited answer to this insolent speech, and began to fortify their frontier. They had already inclosed all the lands of the republic with intrenchments; and to these they now added a wall of six miles in length on the west side, where an invasion was most to be apprehended; and so well did they defend themselves, that though they were frequently attacked by the neighbouring states in alliance with Mexico, or subject to it, not one of them was able to wrest a foot of ground from them. Thus a continual series of wars and engagements took place between the states of Mexico and this republic, which continued till the arrival of the Spaniards. The most remarkable occurrences in these wars are the exploits of a Tlascalan general named Tlahuicol. His courage and strength were so great, that his enemies fled wherever he appeared. The sword with which he fought was so weighty, that no man of ordinary strength could lift it from the ground. At last, however, having in the heat of an engagement got into a marsh, his great strength was of no use to him, so that he was taken prisoner, put into a strong cage, and carried to Mexico. The emperor, in consideration of his extraordinary qualities, gave him liberty to return to his own country: but this he absolutely refused, saying, that he wished to die, like other prisoners, in honour of their god. In this he persisted obstinately for several years; until at last Montezuma resolved to comply with his barbarous desire; and he was permitted to die by the gladiatorian sacrifice, to be afterwards described, in which the prisoner was allowed, though under great disadvantages, to fight for his life. He was opposed by several brave men, one at a time, of whom he killed eight, and wounded twenty more; until, falling almost dead by a violent blow he received on the head, he was carried to the temple and there sacrificed.

During the remainder of Montezuma's reign the empire was disturbed by various rebellions, of which the accounts are not sufficiently interesting to merit a particular detail; but in the year 1508, Montezuma began to entertain apprehensions of that fatal event which at length overtook him. An expedition having been undertaken against a very distant region named Amatlá, the army in marching over a lofty mountain were attacked by a furious north-wind, accompanied with snow; which made great havock in the army, many of them perishing with cold, and others being killed by the trees rooted up by the wind. The remains of the army continued their march to Amatlá, where they were almost all killed in battle. By this and other calamities, together with the appearance of a comet, the Mexicans were thrown into the utmost consternation. Montezuma was so terrified by these omens, that having in vain consulted his astrologers, he applied to the king of Acolhuacan, who was reported to be very skilful in divination. Nezahualpilli having conferred with him at length upon the subject, told Montezuma that the comet presaged some calamity which was about to befall their kingdoms by the

Mexico.

71
Exploits
and death
of Tlahuicol.72
Apprehension entertained by the Mexicans of the arrival of a new people.

4 N

arrival

Mexico.

arrival of a new people: but this being unsatisfactory to the emperor, the king of Acolhuacan challenged him to a game at foot-ball, staking the truth of his prediction on the issue of the game. Montezuma lost the game, but did not yet acquiesce in the truth of his prediction. He therefore applied to a celebrated astrologer, whom it seems he had not yet consulted; but he confirmed the interpretation of Nezahualpilli: for which the emperor caused his house to be pulled down, and himself buried in the ruins.

73
Story of the
resurrec-
tion of a
princess.

Many other presages of the arrival of the Spaniards are related. The following, though apparently the most incredible of them all, seems to be believed by Clavigero. "A sister of Montezuma named Papantzin, who had been married to the governor of Tlatelolco, lived in his palace after he was dead to the year 1509, when she died of old age. The day after her burial a child of five or six years old happened to pass from her mother's apartment to that of the major-domo of the deceased princess. In passing by, the child saw the princess sitting upon the steps of the fountain where she had been accustomed to bathe, and heard herself called by the name of *cocoton*, a Mexican expression of endearment, signifying "little girl." The child, incapable from its age of reflecting on the death of the princess, approached without fear, and was desired to call the wife of her major-domo. The woman caressed the child, and told her that the princess was dead; but being importuned and pulled by the gown, she at last went; but no sooner saw the princess than she fainted. The child then ran to call her mother, who with two other women came to the assistance of the wife of the major-domo; but they also would have fainted, had not the princess called to them, and assured them that she was really alive. Having caused them call the major-domo, she desired him to go and tell Montezuma what he had seen: but he, dreading the severity of the emperor, durst not undertake the task. She then desired him to go to Tezeuco, and tell Nezahualpilli that she wished to see him. He came accordingly, and at her desire brought Montezuma; whom she informed, that during the time she lay entranced she had seen a vision. The main purport of this vision was to announce to her, that all her forefathers were damned; that another race of men should arrive, who should conquer the kingdom, and introduce the true religion; and "as soon as the bath should be published and made known, which would wash away sin, she should be the first to accept of it."

74
The expecta-
tion of
the Mexi-
cans ac-
counted
for.

There can be very little doubt that this story is a fiction of the Spanish priests, though it cannot be doubted that the Mexicans had some expectations of the arrival of the Spaniards among them at the time they actually came. This, however, we may account for without having recourse to any thing the least supernatural, or out of the ordinary course of things. The West India islands had been discovered by Columbus in 1492: he had made frequent voyages, and had even discovered the continent. Settlements had been made; the Spaniards had shown their prowess and their cruelty; and we are not to doubt, that many of the islanders would quit their habitations to escape the fury of the invaders. It would naturally occur to these fugitives, that the arms of these new comers could not be resisted by those of the western nations, while

their relentless cruelty might easily suggest that they would destroy all before them. From the year 1492, therefore, to 1508, there was time enough for this report to have reached Mexico: and we can only attribute it to the barbarous state in which the Americans were, that the Spaniards were not perfectly known and described before their arrival.

But whatever were the omens by which the arrival of the Spaniards was announced, they appear to have had no effect in working any reformation upon Montezuma or his Mexicans. Instead of relaxing any thing from the barbarity of their religion, they seem to have augmented it. Wars were carried on every where, and prisoners sacrificed by thousands; insomuch, that Montezuma finding the stone on which the prisoners were sacrificed too small, he caused one of monstrous size to be put in its place. It was dragged along by an immense number of people: but, in passing a wooden bridge over a canal, in the entry to the city, the bridge broke down by its enormous weight, and dragged several people into the water, among whom was the high-priest, who had accompanied it on the road, scattering incense as he went along. This misfortune disconcerted them considerably: nevertheless the stone, by dint of excessive labour, was got up again, and consecrated by the murder of 12,200 prisoners. The time, however, was now at hand when this horrible and never-ceasing butchery was to be ended, and a most severe vengeance to overtake the perpetrators. The Spaniards having established themselves pretty well in the island of Cuba and Hispaniola, now prepared to explore the continent also, with a view to extend the dominions of their sovereign, and to satiate, if possible, their own appetites for wealth.

Mexico itself was first discovered, though imperfectly, by a Spaniard named *Nunez de Balboa*; but in 1518 the conquest of it was undertaken by a celebrated adventurer named *Ferdinando Cortes*. It was not, however, without great difficulty that he got his expedition set on foot; being persecuted by the Spanish governors in the West Indies, so that he was at last obliged to throw off his allegiance to them, and proceed without any commission. However, on the 10th of February 1519, he set sail from the Havannah in Cuba; and soon landed on the island of Cozumel, on the coast of Yucatan, discovered the preceding year. Here he joined one of his officers named *Pedro d'Alvaredo*, who had arrived some days before, and collected some booty and taken a few prisoners. But the general severely censured his conduct; and the prisoners were dismissed, after they had been informed by an Indian interpreter named *Melchior*, that such injuries were entirely disagreeable to the intentions and wishes of Cortes. Here he mustered his army, and found that it amounted to 508 soldiers, 16 horsemen, and 109 mechanics, pilots, and mariners. Having encouraged his men by a proper speech, and released, by means of some Indian ambassadors, a Spaniard named *Jerom de Aguilar*, who had been detained a prisoner for eight years, he proceeded to the river Tabasco, where he hoped to be received in a friendly manner, as one Grijalva had been a short time before; but, from some unknown cause, he was violently attacked by them: however, the superiority of the Spanish arms soon decided the victory, and the inhabitants

Mexico.

75
Vast num-
bers of hu-
man sacri-
fices.

76
Conquest of
Mexico un-
dertaken by
Cortes.

Mexico. were obliged to own the king of Castile as their sovereign.

77 Receives an embassy from the emperor of Mexico. The Spaniards then continued their course westward, to the harbour of St Juan de Ullua; where they were met by two Mexican canoes, who carried two ambassadors from the emperor of that country, and showed the greatest signs of peace and amity. Their language was unknown to Aguilar; but one of the female prisoners above-mentioned understood it, and translated it into the Yucatan tongue; after which Aguilar interpreted the meaning in Spanish. This slave was afterwards named *Donna Marina*, and proved very useful in their conferences with the natives.

78 State of the empire at that time. At this time the Mexican empire, according to Dr Robertson, was arrived at a pitch of grandeur to which no society had ever attained in so short a period. Though it had subsisted only for 130 years, its dominion extended from the north to the south sea; over territories stretching about 500 leagues from east to west, and more than 200 from north to south; comprehending provinces not inferior in fertility, population, and opulence, to any in the torrid zone.— Though by nature Montezuma possessed a good deal of courage and resolution; yet from the first moment that the Spaniards appeared on his coast, he discovered symptoms of timidity and embarrassment, and all his subjects were embarrassed as well as himself. The general dismay which took place on this occasion was partly owing to the strange figure the Spaniards made, and the prodigious power of their arms; but partly also to the following circumstance. An opinion prevailed almost universally among the Americans, that some dreadful calamity impended over their heads, from a race of formidable invaders who should come from regions towards the rising sun, to over-run and desolate their country. The origin of this we have already attempted to explain; but as the Mexicans were more prone to superstition than any people in the new world, they were more deeply affected with the appearance of the Spaniards, whom they instantly supposed to be the instruments destined to bring about that fatal revolution which they dreaded: and this produced the embassy above-mentioned.

By means of his two interpreters, Donna Marina and Aguilar, Cortes learned that the chiefs of the Mexican embassy were deputies from Pilpatoe and Teutile; the one governor of a province under the emperor, and the other the commander of all his forces in that province: the purport of their embassy was, to inquire what his intentions were in visiting their coasts, and to offer him what assistance he might need in order to continue his voyage. Cortes, in his turn, also professed the greatest friendship; and informed the ambassadors, that he came to propose matters of the utmost consequence to the welfare of the prince and his kingdom; which he would more fully unfold in person to the governor and the general. Next morning, without waiting for any answer, he landed his troops, his horses, and his artillery; began to erect huts for his men, and to fortify his camp.— The natives, instead of opposing the entrance of these fatal guests into their country, assisted them in all their operations with an alacrity which they had ere long reason to repent.

79 Cortes lands and fortifies his camp.

The next day the ambassadors had a formal audience; at which Cortes acquainted them, that he came from Don Carlos of Austria, king of Castile, the greatest monarch of the east, and was intrusted with propositions of such moment, that he would impart them to none but the emperor himself, and therefore required to be conducted immediately to the capital. This demand produced the greatest uneasiness; and the ambassadors did all in their power to dissuade Cortes from his design, endeavouring to conciliate his good-will by the presents sent him by Montezuma. These they introduced with great parade, and consisted of fine cotton-cloth, of plumes of various colours, and of ornaments of gold and silver to a considerable value, the workmanship of which appeared to be as curious as the materials were rich. But these presents served only to excite the avidity of the Spaniards, and to increase their desire for becoming masters of a country which abounded with so many precious commodities. Cortes indeed could scarcely restrain himself so far as to hear the arguments made use of by the ambassadors to dissuade him from going to the capital; and, in a haughty, determined tone, insisted on his former demand of being admitted to a personal interview with their sovereign.

During this conversation, some painters in the retinue of the Mexican chiefs had been diligently employed in delineating, upon white cotton cloths, figures of the ships, horses, artillery, soldiers, and whatever else attracted their eyes as singular. When Cortes observed this, and was informed that these pictures were to be sent to Montezuma, he resolved to render the representation still more striking and interesting. The trumpets, by his orders, sounded an alarm; the troops formed in order of battle, and showed their agility and strength in the best manner they could; while the artillery was pointed against the neighbouring trees, among which it made dreadful havock. The Indians for some time looked on with silent astonishment; but at the explosion of the cannon, some fled, others fell to the ground, and all were so confounded, that Cortes found it difficult to quiet and compose their minds.

When the painters had exerted their utmost efforts in representing all these wonderful things, messengers were immediately dispatched to Montezuma with the pictures, and a full account of every thing that had passed since the arrival of the Spaniards, together with some European curiosities to Montezuma; which, though of no great value, Cortes believed would be acceptable on account of their novelty. The Mexican monarchs, in order to obtain the earliest information of every occurrence in all parts of their empire, had couriers posted at proper stations along the principal roads; and as these were trained to agility by a regular education, they conveyed intelligence with surprising rapidity. Though the city in which Montezuma resided was above 180 miles from St Juan de Ullua, Cortes's presents were carried thither, and an answer returned to his demands, in a few days. As the answer was unfavourable, Montezuma had endeavoured to mollify the Spanish general by the richness of his presents. These consisted of the manufactures of the country; cotton-stuffs so fine, and of such

Mexico.

80 The Indians endeavoured to dissuade him from going to the capital, but in vain.

81 Montezuma made acquainted with his design.

Mexico.

82
Sends an unfavourable answer, but accompanied with rich presents.

delicate texture, as to resemble silk; pictures of animals, trees, and other natural objects, formed with feathers of different colours, disposed and mingled with such skill and elegance as to rival the works of the pencil in truth and beauty of imitation. But what chiefly attracted their attention, were two large plates of a circular form; one of massive gold representing the sun, the other of silver representing the moon. These were accompanied with bracelets, collars, rings, and other trinkets of gold; and that nothing might be wanting which could give the Spaniards a complete idea of what the country afforded, some boxes filled with pearls, precious stones, and grains of gold unwrought, as they had been found in the mines or rivers, were sent along with the rest. Cortes received all with an appearance of the most profound respect for Montezuma; but when the Mexicans, presuming upon this, informed him, that their master, though he desired him to accept of what he had sent as a token of his regard for the prince whom he represented, would not give his consent that foreign troops should approach nearer to his capital, or even allow them to continue longer in his dominions, Cortes declared, in a manner more resolute and peremptory than formerly, that he must insist on his first demand; as he could not, without dishonour, return to his own sovereign until he was admitted into the presence of the prince whom he was appointed to visit in his name. The Mexicans were astonished at the sight of a man who dared to oppose the will of their emperor; but not being willing to come to an open rupture with such formidable enemies, with much ado they prevailed upon Cortes to promise that he would not move from his present camp until the return of a messenger whom they sent to Montezuma for further instructions.

83
Cortes still insists on his demands.

84
Montezuma peremptorily commands him to leave his dominions.

The pusillanimity of the Indian monarch afforded time to the Spaniards to take measures which would have been out of their power had they been vigorously attacked on their first refusal to obey his orders. Cortes used every method of securing the affections of the soldiers; which indeed was very necessary, as many of them began to exclaim against the rashness of his attempt in leading them against the whole force of the Mexican empire. In a short time Teutile arrived with another present from Montezuma, and together with it delivered the ultimate orders of that monarch to depart instantly out of his dominions; and when Cortes, instead of complying with his demands, renewed his request of audience, the Mexican immediately left the camp with strong marks of surprise and resentment. Next morning, none of the natives appeared; all friendly correspondence seemed to be at an end, and hostilities were expected to commence every moment. A sudden consternation ensued among the Spaniards, and a party was formed against him by the adherents of Velasques; who took advantage of the occasion, and deputed one of their number, a principal officer, to remonstrate, as if in name of the whole army, against his rashness, and to urge the necessity of his returning to Cuba. Cortes received the message without any appearance of emotion; and as he well knew the temper and wishes of his soldiery, and foresaw how they would receive a proposition so fatal to all the splendid hopes and schemes which they had been forming

with such complacency, he pretended to comply with the request now made him, and issued orders that the army should be in readiness next day to embark for Cuba. Upon hearing this, the troops, as Cortes had expected, were quite outrageous: they positively refused to comply with these orders, and threatened immediately to choose another general if Cortes continued to insist on their departure.

Our adventurer was highly pleased with the disposition which now appeared among his troops: nevertheless, dissembling his sentiments, he declared, that his orders for embarking had proceeded from a persuasion that it was agreeable to his fellow-soldiers, to whose opinion he had sacrificed his own; but now he acknowledged his error, and was ready to resume his original plan of operation. This speech was highly applauded; and Cortes, without allowing his men time to cool, set about carrying his designs into execution. In order to give a beginning to a colony, he assembled the principal persons in his army, and by their suffrages elected a council and magistrates, in whom the government was to be vested. The persons chosen were most firmly attached to Cortes; and the new settlement had the name of *Villa Rica de la Vera Cruz*; that is, the rich town of the true cross.

85
Villa Rica founded.

Before this court of his own making, Cortes did not hesitate at resigning all his authority, and was immediately re-elected chief-justice of the colony, and captain-general of his army, with an ample commission, in the king's name, to continue in force till the royal pleasure should be farther known. The soldiers eagerly ratified their choice by loud acclamations; and Cortes, now considering himself as no longer accountable to any subject, began to assume a much greater degree of dignity, and to exercise more extensive powers than he had done before. Some of the soldiers began to exclaim against the proceedings of the council as illegal; but the ringleaders were instantly sent on board the fleet loaded with irons. By this timely severity the rest were overawed; and Cortes, knowing of how great importance unanimity was to his future success, soon found means to reconcile those who were most disaffected; to which purpose a liberal distribution of the Mexican gold, both among friends and foes, contributed not a little.

86
The government of the new colony vested in Cortes.

Cortes having thus strengthened himself as well as he could, resolved to advance into the country; and to this he was encouraged by the behaviour of the cacique or petty prince of Zempoalla, a considerable town at no great distance. This prince, though subject to Montezuma, was exceedingly impatient of the yoke; and so filled with dread and hatred of the emperor, that nothing could be more acceptable to him than an appearance of being delivered from that subjection; and a deliverance of this kind he now hoped from the Spaniards. For this reason, he sent ambassadors to Cortes, with offers of friendship, which were gladly accepted by him; and in consequence of the alliance, he very soon visited Zempoalla. Here he was received in the most friendly manner imaginable, and had a respect paid towards him almost equivalent to adoration. The cacique informed him of many particulars relating to the character of Montezuma. He told him that he was a tyrant, haughty, cruel,

87
Makes an alliance with the cacique of Zempoalla.

88
Character of Montezuma given by the cacique.

Mexico. and suspicious; who treated his own subjects with arrogance, ruined the conquered provinces by his extortions, and often tore their sons and daughters from them by violence; the former to be offered as victims to his gods, the latter to be reserved as concubines for himself and favourites. Cortes, in reply, artfully insinuated, that one great object of the Spaniards in visiting a country so remote from their own was, to redress grievances, and to relieve the oppressed; and having encouraged him to hope for this interposition in due time, continued his march to Quiabisslan, the territory of another cacique, and where, by the friendly aid of the Indians, a Spanish colony was soon formed.

During the residence of Cortes in these parts, he so far wrought on the minds of the caciques of Zempoalla and Quiabisslan, that they ventured to insult the Mexican power, at the very name of which they had been formerly accustomed to tremble. Some of Montezuma's officers having appeared to levy the usual tribute, and to demand a certain number of human victims, as an expiation of their guilt in presuming to hold intercourse with those strangers whom the emperor had commanded to leave his dominions; instead of obeying his orders, they made them prisoners, treated them with great indignity, and, as their superstition was no less barbarous than Montezuma's, they threatened to sacrifice them to their gods. From this last danger, however, they were delivered by the interposition of Cortes, who manifested the utmost horror at the mention of such a deed. This act of rebellion firmly attached the two caciques to the interest of Cortes; and without hesitation they acknowledged themselves vassals of the king of Spain. Their example was followed by the Totonagues, a fierce people who inhabited the mountainous parts of the country. They willingly subjected themselves to the crown of Castile; and offered to accompany Cortes with all their forces in his march towards Mexico.

89
The caciques of Zempoalla, Quiabisslan, and some others, submit.

90
The magistrates of Villa Rica send a letter to the king of Spain in favour of Cortes.

Though Cortes had now taken such measures as in a manner ensured his success; yet as he had thrown off all dependence on the governor of Cuba, who was his lawful superior, and apprehended his interest at court, he thought proper, before he set out on his intended expedition, to take the most effectual measures against the impending danger. With this view, he persuaded the magistrates of his colony to address a letter to the king, containing a pompous account of their own services, of the country they had discovered, &c. and of the motives which had induced them to throw off their allegiance to the governor of Cuba, and to settle a colony dependent on the crown alone, in which the supreme power civil as well as military had been vested in Cortes; humbly requesting their sovereign to ratify what had been done by his royal authority. Cortes himself wrote in a similar strain; but as he knew that the Spanish court, accustomed to the repeated exaggerations of American adventurers, would give little credit to the splendid accounts of New Spain, if they were not accompanied with such a specimen of what it contained as would excite an high idea of its opulence, he solicited his soldiers to relinquish what they might claim as their part of the treasures which had hitherto been collected, in order

that the whole might be sent to the king. Portocarrero and Montejo, the chief magistrates of the colony, were appointed to carry this present to Castile, with express orders not to touch at Cuba in their passage thither. But while a vessel was preparing for their departure, an unexpected event produced a general alarm. Some soldiers and sailors, secretly disaffected to Cortes, formed a design of seizing one of the brigantines, and making their escape to Cuba, in order to give such intelligence to the governor as might enable him to intercept the vessel which was to carry the treasure and dispatches to Spain. This conspiracy was conducted with profound secrecy; but at the moment when every thing was ready for execution, the secret was discovered by one of the associates. The latent spirit of disaffection which Cortes was now too well convinced had not been extinguished amongst his troops, gave him very great uneasiness. The only method which he could think of to prevent such conspiracies for the future was, to destroy his fleet; and thus deprive his soldiers of every resource except that of conquest: and with this proposal he persuaded his men to comply. With universal consent therefore the ships were drawn ashore, and, after being stripped of their sails, rigging, iron-work, and whatever else might be of use, they were broke in pieces.

Mexico.

91
Cortes burns his fleet.

Cortes having thus rendered it necessary for his troops to follow wherever he chose to lead, began his march to Zempoalla with 500 infantry, 15 horse, and six field-pieces. The rest of his troops, consisting chiefly of such as from age or infirmity were less fit for active service, he left as a garrison in Villa Rica, under the command of Escalante, an officer of merit, and warmly attached to his interest. The cacique of Zempoalla supplied him with provisions; and with 200 of those Indians called *Tamames*, whose office, in a country where tame animals were unknown, was to carry burdens, and perform all manner of servile labour. He offered likewise a considerable body of troops; but Cortes was satisfied with 400; taking care, however, to choose persons of such note, that they might serve as hostages for the fidelity of their master.

Nothing memorable happened till the Spaniards arrived on the confines of the republic of Tlascala. The inhabitants of that province were warlike, fierce, and revengeful, and had made considerable progress in agriculture and some other arts. They were implacable enemies to Montezuma; and therefore Cortes hoped that it would be an easy matter for him to procure their friendship. With this view, four Zempoallans of high rank were sent ambassadors to Tlascala, dressed with all the badges of that office usual among the Indians. The senate were divided in their opinions with regard to the proposals of Cortes: but at last Magiscatzin, one of the oldest senators, and a person of great authority, mentioned the tradition of their ancestors, and the revelations of their priests; that a race of invincible men, of divine origin, who had power over the elements, should come from the east to subdue their country. He compared the resemblance which the strangers bore to the persons figured in the tradition of Mexico, their dominion over the elements of fire, air, and water; he reminded

92
Sends ambassadors to the republic of Tlascala.

the

Mexico.

the Tenate of their prodigies, omens, and signals, which had lately terrified the Mexicans, and indicated some very important event; and then declared his opinion, that it would be rashness to oppose a force apparently assisted by heaven, and men who had already proved, to the sad experience of those who opposed them, that they were invincible. This orator was opposed by Xicotencal, who endeavoured to prove that the Spaniards were at best but powerful magicians: that they had rendered themselves obnoxious to the gods by pulling down their images and altars, (which indeed Cortes had very imprudently done at Zempoalla); and of consequence, that they might easily be overcome, as the gods would not fail to resent such an outrage. He therefore voted for war, and advised the crushing of these invaders at one blow.

93
The Tlascalans resolve on war.

The advice of Xicotencal prevailed; and in consequence of it, the ambassadors were detained; which giving Cortes the alarm, he drew nearer the city of Tlascala. In this transaction we may easily see how little the Tlascalans, notwithstanding all their ferocity, were skilled in military affairs. They suffered Cortes, with his army drawn up in good order, to pass a strong wall between two mountains, which might have been very advantageously defended against him. He had not advanced far beyond this pass, however, before a party of Tlascalans with plumes were discovered, which denoted that an army was in the field. These he drove before him by a detachment of six horse, obliged them to join another party, and then reinforcing the advanced detachment, charged the enemy with such vigour that they began to retire. Five thousand Tlascalans, whom Xicotencal had placed in ambush, then rushed out of their hiding places, just as the infantry came up to assist their slender body of cavalry. The enemy attacked with the utmost fury; but were so much disconcerted by the first discharge of the fire-arms, that they retreated in confusion, furnishing the Spaniards with an opportunity of pursuing them with great slaughter. Cortes, however, supposing that this could not be their whole force, advanced with the utmost caution, in order of battle, to an eminence, from whence he had a view of the main body of the Tlascalan army commanded by Xicotencal, consisting of no fewer than 40,000 men. By these the small army of Cortes was entirely surrounded; which Xicotencal no sooner perceived, than he contracted the circle with incredible diligence, while the Spaniards were almost overwhelmed with showers of arrows, darts, and stones. It is impossible but in this case many of the Spaniards must have perished, had it not been for the insufficiency of the Indian weapons. Their arrows and spears were headed only with flint, or the bones of fishes; their stakes hardened in the fire, and wooden swords, though destructive weapons among naked Indians, were easily turned aside by the Spanish bucklers, and could hardly penetrate the quilted jackets which the soldiers wore. These circumstances gave the Spaniards a prodigious advantage over them; and therefore the Tlascalans, notwithstanding their valour and superiority in number, could accomplish no more in the present instance, than to kill one horse and slightly wound nine soldiers.

Mexico.

The Tlascalans being taught by this, and some subsequent encounters, how much they were inferior to the Spaniards, began to conceive them to be really what Magiscatzin had said; a superior order of beings, against whom human power could not prevail. In this extremity they had recourse to their priests, requiring them to reveal the causes of such extraordinary events, and to declare what means they should take to repel such formidable invaders. The priests, after many sacrifices and incantations, delivered their response, That these strangers were the offspring of the sun, procreated by his animating energy in the regions of the east: that, by day, while cherished with the influence of his parental beams, they were invincible; but by night, when his reviving heat was withdrawn, their vigour declined and faded like herbs in the field, and they dwindled down into mortal men. In consequence of this, the Tlascalans acted in contradiction to one of their most established maxims in war, and ventured to attack the enemy in the night-time, hoping to destroy them when enfeebled and surprised. But the Spanish centinels having observed some extraordinary movements among the Tlascalans, gave the alarm. Immediately the troops were under arms, and falling out, defeated their antagonists with great slaughter, without allowing them to approach the camp. By this disaster the Tlascalans were heartily disposed to peace; but they were at a loss to form an adequate idea of the enemies they had to deal with. They could not ascertain the nature of these surprising beings, or whether they were really of a benevolent or malignant disposition. There were circumstances in their behaviour which seemed to favour each opinion. On the one hand, as the Spaniards constantly dismissed the prisoners whom they took, not only without injury, but often with presents of European toys, and renewed their offers of peace after every victory; this lenity amazed people accustomed to the exterminating system of war known in America, and who sacrificed and devoured without mercy all the captives taken in battle; and disposed them to entertain sentiments favourable to their humanity. But, on the other hand, as Cortes had seized 50 of their countrymen who brought provisions to their camp, and cut off their heads; this bloody spectacle, added to the terror occasioned by the fire-arms and horses, filled them with dreadful ideas of their ferocity. Accordingly they addressed them in the following manner: "If (said they) you are divinities of a cruel and savage nature, we present to you five slaves, that you may drink their blood and eat their flesh. If you are mild deities, accept an offering of incense and variegated plumes. If you are men, here is meat, bread, and fruit, to nourish you." After this address, the peace was soon concluded, to the great satisfaction of both parties. The Tlascalans yielded themselves as vassals to the crown of Castile, and engaged to assist Cortes in all his operations; while he took the republic under his protection, and promised to defend their persons and possessions from injury and violence.

94
But are defeated, and sue for peace.

This reconciliation took place at a very seasonable juncture for the Spaniards. They were not only worn out with incessant toil, but so destitute of necessaries, that they had no other salve to dress their wounds but what

95
Which is granted.

96
Great distresses of the Spaniards.

Mexico. what was composed of the fat of Indians whom they had slain. Their distresses, in short, were arisen to such an height, that they had begun to murmur, and even to despair, insomuch that Cortes had much difficulty in restraining them within any kind of bounds; but the submission of the Tlascalans, and their own triumphant entry into the city, where they were received with the reverence due to a superior order of beings, banished at once all memory of past sufferings, dispelled every anxious thought, and fully convinced them that they could not be resisted by any power in America.

97
Cortes continues his march for Mexico.

98
Treachery of Montezuma and the Cholulans.

Cortes left no method untried to gain the favour and confidence of the Tlascalans; which, however, he had almost entirely lost, by his untimely zeal in destroying their idols as he had done those of Zempoalla. But he was deterred from this rash action by his chaplain, father Bartholomew de Olmado; and left the Tlascalans in the undisturbed exercise of their superstition, requiring only that they should desist from their horrid practice of offering human victims. As soon as his troops were fit for service, he resolved to continue his march towards Mexico, notwithstanding the remonstrances of the Tlascalans, who looked upon his destruction as unavoidable if he put himself into the power of such a faithless prince as Montezuma. But the emperor, probably intimidated with the fame of his exploits, had resolved to admit his visit; and informed Cortes that he had given orders for his friendly reception at Cholula, the next place of any consequence on the road to Mexico. In this, however, he was by no means sincere. Cholula was looked upon by all the inhabitants of the empire as a very holy place; the sanctuary and chief seat of their gods, to which pilgrims resorted from every province, and a greater number of human victims were offered in its principal temple than even in that of Mexico. Montezuma therefore invited the Spaniards thither, either from some superstitious hope that the gods would not suffer this sacred mansion to be defiled; or from a belief, that he himself might there find an opportunity of cutting them off with more certainty of success, when under the immediate protection of his gods. Cortes, however, was received with much seeming cordiality; but 6000 Tlascalcan troops who accompanied him were obliged to remain without the town, as the Cholulans refused to admit their ancient enemies within their precincts. Yet two of these, by disguising themselves, got into the city, and acquainted Cortes that they observed the women and children belonging to the principal citizens retiring every night in a great hurry, and that six children had been sacrificed in the great temple; a sign that some warlike enterprise was at hand. At the same time Donna Marina, the interpreter, received information from an Indian woman of distinction, whose confidence she had gained, that the destruction of the Spaniards was concerted; that a body of Mexican troops lay concealed near the town; that some of the streets were barricaded, in others deep pits or trenches were dug, and slightly covered over, as traps into which the horse might fall; that stones and missile weapons were collected on the tops of the temples, with which to overwhelm the infantry; that the fatal hour was already at hand, and their ruin unavoidable. Cortes, alarmed at this news, secretly ar-

rested three of the chief priests, from whom he extorted a confession that confirmed the intelligence he had already received. As not a moment was to be lost, he instantly resolved to prevent his enemies, and to inflict on them such dreadful vengeance as might strike Montezuma and his subjects with terror. For this purpose the Spaniards and Zempoallans were drawn up in a large court, which had been allotted for their quarters, near the centre of the town; the Tlascalans had orders to advance; the magistrates and chief citizens were sent for under various pretexts, and seized. On a signal given, the troops rushed out, and fell upon the multitude, destitute of leaders, and so much astonished, that the weapons dropped from their hands, and they stood motionless, and incapable of defence. While the Spaniards attacked them in front, the Tlascalans did the same in the rear; the streets were filled with slaughter; the temples, which afforded a retreat to the priests and some leading men, were set on fire, and they perished in the flames. This scene of horror continued two days, during which the wretched inhabitants suffered all that the destructive rage of the Spaniards, or the implacable revenge of their Indian allies, could inflict. At length the carnage ceased, after the slaughter of 6000 Cholulans, without the loss of a single Spaniard. Cortes then released the magistrates; and reproaching them bitterly for their intended treachery, declared, that as justice was now appeased, he forgave the offence; but required them to recal the inhabitants who had fled, and re-establish order in the town. Such was the ascendant that the Spaniards had now obtained over this superstitious race, that this order was instantly complied with; and the city was in a few days again filled with people, who paid the most respectful service to those men whose hands were stained with the blood of their relations and fellow-citizens.

From Cholula, Cortes advanced directly towards Mexico; and throughout the whole of his journey was entertained with accounts of the oppressions and cruelty of Montezuma. This gave him the greatest hope of accomplishing his design; as he now perceived that the empire was entirely divided, and no sort of unanimity prevailed among them. No enemy appeared to check his progress. Montezuma was quite irresolute; and Cortes was almost at the gates of the capital before the emperor had determined whether to receive him as a friend or oppose him as an enemy. But as no sign of open hostility appeared, the Spaniards, without regarding the fluctuations of Montezuma's sentiments, continued their march to Mexico, with great circumspection and the strictest discipline, though without seeming to suspect the prince whom they were about to visit.

When they drew near the city, about 1000 persons, who appeared to be of distinction, came forth to meet them, adorned with plumes, and clad in mantles of fine cotton. Each of these, in his order, passed by Cortes, and saluted him according to the mode deemed most respectful and submissive in their country. They announced the approach of Montezuma himself, and soon after his harbingers came in sight. There appeared first 200 persons in an uniform dress, with large plumes of feathers, alike in fashion, marching two and two, in deep silence, barefooted, with their eyes fixed on the ground. These were followed by a company of higher rank.

Mexico.
99
Severe punishment of the Cholulans.

100
Disaffection of Montezuma's subjects.

101
Meeting of Cortes and Montezuma.

Mexico.

rank, in their most showy apparel; in the midst of whom was Montezuma, in a chair or litter richly ornamented with gold, and feathers of various colours. Four of his principal favourites carried him on their shoulders, others supported a canopy of curious workmanship over his head. Before him marched three officers with rods of gold in their hands, which they lifted up on high at certain intervals; and at that signal all the people bowed their heads, and hid their faces, as unworthy to look on so great a monarch. When he drew near, Cortes dismounted, advancing towards him with officious haste, and in a respectful posture. At the same time Montezuma alighted from his chair, and leaning on the arms of two of his near relations, approached with a slow and stately pace, his attendants covering the street with cotton cloths, that he might not touch the ground. Cortes accosted him with profound reverence, after the European fashion. He returned the salutation, according to the mode of his country, by touching the earth with his hand, and then kissing it. This ceremony, the customary expression of reverence from inferiors towards those who are above them in rank, appeared such amazing condescension in a proud monarch, who scarcely deigned to consider the rest of mankind as of the same species with himself, that all his subjects firmly believed those persons, before whom he humbled himself in this manner, to be something more than human. Accordingly, as they marched through the crowd, the Spaniards frequently, and with much satisfaction, heard themselves denominated *teules*, or *divinities*. Nothing material passed in this first interview. Montezuma conducted Cortes to the quarters which he had prepared for his reception; and immediately took leave of him, with a politeness not unworthy of a court more refined. "You are now (says he), with your brothers, in your own house; refresh yourselves after your fatigue, and be happy until I return." The place allotted to the Spaniards for their lodging was a house built by the father of Montezuma. It was surrounded by a stone-wall, with towers at proper distances, which served for defence as well as for ornament; and its apartments and courts were so large as to accommodate both the Spaniards and their Indian allies. The first care of Cortes was to take precautions for his security, by planting the artillery so as to command the different avenues which led to it, by appointing a large division of his troops to be always on guard, and by posting centinels at proper stations, with injunctions to observe the same vigilant discipline as if they were within sight of an enemy's camp.

In the evening Montezuma returned to visit his guests with the same pomp as in their first interview; and brought presents of such value, not only to Cortes and to his officers, but even to the private men, as proved the liberality of the monarch to be suitable to the opulence of his kingdom. A long conference ensued, in which Cortes learned what was the opinion of Montezuma with respect to the Spaniards. It was an established tradition, he told him, among the Mexicans, that their ancestors came originally from a remote region, and conquered the provinces now subject to his dominion; that after they were settled there, the great captain who conducted this colony returned to his own country, promising, that at some future period his de-

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scendants should visit them, assume the government, and reform their constitutions and laws; that, from what he had heard and seen of Cortes and his followers, he was convinced that they were the very persons whose appearance and prophecies taught them to expect; that accordingly he had received them, not as strangers, but as relations of the same blood and parentage, and desired that they might consider themselves as masters in his dominions; for both himself and his subjects should be ready to comply with their will, and even to prevent their wishes. Cortes made a reply in his usual style with respect to the dignity and power of his sovereign, and his intention in sending him into that country; artfully endeavouring so to frame his discourse, that it might coincide as much as possible with the idea which Montezuma had formed concerning the origin of the Spaniards. Next morning, Cortes and some of his principal attendants were admitted to a public audience of the emperor. The three subsequent days were employed in viewing the city; the appearance of which, so far superior in the order of its buildings and the number of its inhabitants to any place the Spaniards had beheld in America, and yet so little resembling the structure of an European city, filled them with surprise and admiration.

Mexico, *Tenuchtitlan*, as it was anciently called by the natives, is situated in a large plain, environed by mountains of such height, that though within the torrid zone, the temperature of its climate is mild and healthful. All the moisture which descends from the high grounds is collected in several lakes, the two largest of which, of about 90 miles in circuit, communicate with each other. The waters of the one are fresh, those of the others brackish. On the banks of the latter, and on some small islands adjoining to them, the capital of Montezuma's empire was built. The access to the city was by artificial causeways or streets, formed of stones and earth, about 30 feet in breadth. As the waters of the lake, during the rainy season, overflowed the flat country, these causeways were of considerable length. That of Tacuba on the west a mile and a half; that of Tezenco on the north-west three miles; that of Cuoyacan towards the south six miles. On the east there was no causeway, and the city could be approached only by canoes. In each of these causeways were openings, at proper intervals, through which the waters flowed; and over these beams of timber were laid, which being covered with earth, the causeway or street had every where an uniform appearance. As the approaches to the city were singular, its construction was remarkable. Not only the temple of their gods, but the houses belonging to the monarch and to persons of distinction, were of such dimensions, that, in comparison with any other buildings which had been discovered in America, they might be termed *magnificent*. The habitations of the common people were mean, resembling the huts of other Indians. But they were all placed in a regular manner, on the banks of the canals which passed thro' the city, in some of its districts, or on the sides of the streets which intersected it in other quarters. In several places were large openings or squares, one of which, allotted for the great market, is said to have been so spacious, that 40,000 or 50,000 persons carried on traffic

Mexico.

102
Description
of the city
of Mexico.

Mexico. traffic there. In this city, the pride of the New World, and the noblest monument of the industry and art of man, while unacquainted with the use of iron, and destitute of aid from any domestic animal, the Spaniards, who are most moderate in their computations, reckon that there were at least 60,000 inhabitants.

105
Uneasiness
of the Spaniards.

But how much soever the novelty of those objects might amuse or astonish the Spaniards, they felt the utmost solicitude with respect to their own situation. From a concurrence of circumstances, no less unexpected than favourable to their progress, they had been allowed to penetrate into the heart of a powerful kingdom, and were now lodged in its capital, without having once met with open opposition from its monarch. The Tlascalans, however, had earnestly dissuaded them from placing such confidence in Montezuma as to enter a city of such a peculiar situation as Mexico, where that prince would have them at mercy, shut up as it were in a snare, from which it was impossible to escape. They assured them that the Mexican priests had, in the name of the gods, counselled their sovereign to admit the strangers into the capital, that he might cut them off there at one blow with perfect security. The Spaniards now perceived, too plainly, that the apprehensions of their allies were not destitute of foundation; that, by breaking the bridges placed at certain intervals on the causeways, or by destroying part of the causeways themselves, their retreat would be rendered impracticable, and they must remain cooped up in the centre of a hostile city, surrounded by multitudes sufficient to overwhelm them, and without a possibility of receiving aid from their allies. Montezuma had, indeed, received them with distinguished respect. But ought they to reckon upon this as real, or to consider it as feigned? Even if it were sincere, could they promise on its continuance? Their safety depended upon the will of a monarch in whose attachment they had no reason to confide; and an order flowing from his caprice, or a word uttered by him in passion, might decide irrevocably concerning their fate.

104
Some hostilities between the Spaniards and Mexicans.

These reflections, so obvious as to occur to the meanest soldier, did not escape the vigilant sagacity of their general. Before he set out from Cholula, Cortes had received advice from Villa Rica, that Qualepopoca, one of the Mexican generals on the frontiers, having assembled an army in order to attack some of the people whom the Spaniards had encouraged to throw off the Mexican yoke, Escalante had marched out with part of the garrison to support his allies; that an engagement had ensued, in which, though the Spaniards were victorious, Escalante, with seven of his men, had been mortally wounded, his horse killed, and one Spaniard had been surrounded by the enemy and taken alive; that the head of this unfortunate captive, after being carried in triumph to different cities, in order to convince the people that their invaders were not immortal, had been sent to Mexico. Cortes, though alarmed with this intelligence, as an indication of Montezuma's hostile intentions, had continued his march. But as soon as he entered Mexico, he became sensible, that, from an excess of confidence in the superior valour and discipline of his troops, as well as from the disadvantage of having nothing to guide him in an unknown country but the defective intelligence which he received from people with whom his mode of com-

munication was very imperfect, he had pushed forward into a situation, where it was difficult to continue, and from which it was dangerous to retire. Disgrace, and perhaps ruin, was the certain consequence of attempting the latter. The success of his enterprise depended upon supporting the high opinion which the people of New Spain had formed with respect to the irresistible power of his arms. Upon the first symptom of timidity on his part, their veneration would cease, and Montezuma, whom fear alone restrained at present, would let loose upon him the whole force of his empire. At the same time, he knew that the countenance of his own sovereign was to be obtained only by a series of victories; and that nothing but the merit of extraordinary success could screen his conduct from the censure of irregularity. From all these considerations, it was necessary to maintain his station, and to extricate himself out of the difficulties in which one bold step had involved him, by venturing upon another still bolder. The situation was trying, but his mind was equal to it; and after revolving the matter with deep attention, he fixed upon a plan no less extraordinary than daring. He determined to seize Montezuma in his palace, and carry him a prisoner to the Spanish quarters. From the superstitious veneration of the Mexicans for the person of their monarch, as well as their implicit submission to his will, he hoped, by having Montezuma in his power, to acquire the supreme direction of their affairs; or at least, with such a sacred pledge in his hands, he made no doubt of being secure from any effort of their violence.

Mexico.

105
Cortes resolves to seize Montezuma in his palace.

This he immediately proposed to his officers. The timid startled at a measure so audacious, and raised objections. The more intelligent and resolute, conscious that it was the only resource in which there appeared any prospect of safety, warmly approved of it, and brought over their companions so cordially to the same opinion, that it was agreed instantly to make the attempt. At his usual hour of visiting Montezuma, Cortes went to the palace, accompanied by Alvarado, Sandoval, Lugo, Velasquez de Leon, and Davila, five of his principal officers, and as many trusty soldiers. Thirty chosen men followed, not in regular order, but sauntering at some distance, as if they had no object but curiosity; small parties were posted at proper intervals, in all the streets leading from the Spanish quarters to the court; and the remainder of his troops, with the Tlascalan allies, were under arms, ready to sally out on the first alarm. Cortes and his attendants were admitted without suspicion; the Mexicans retiring, as usual, out of respect. He addressed the monarch in a tone very different from that which he had employed in former conferences; reproaching him bitterly as the author of the violent assault made upon the Spaniards by one of his officers, and demanding public reparation for the loss which he had sustained by the death of some of his companions, as well as for the insult offered to the great prince whose servants they were. Montezuma, confounded at this unexpected accusation, and changing colour either from the consciousness of guilt, or from feeling the indignity with which he was treated, asserted his own innocence with great earnestness; and, as a proof of it, gave orders instantly to bring Qualepopoca and his accomplices prisoners to Mexico. Cortes replied, with seeming complaisance, that a declaration so respectable left no doubt

Mexico. remaining in his own mind ; but that something more was requisite to satisfy his followers, who would never be convinced that Montezuma did not harbour hostile intentions against them, unless, as an evidence of his confidence and attachment, he removed from his own palace and took up his residence in the Spanish quarters, where he should be served and honoured as became a great monarch. The first mention of so strange a proposal bereaved Montezuma of speech, and almost of motion. At length he haughtily answered, " That persons of his rank were not accustomed voluntarily to give up themselves as prisoners ; and were he mean enough to do so, his subjects would not permit such an affront to be offered to their sovereign." Cortes, unwilling to employ force, endeavoured alternately to soothe and intimidate him. The altercation became warm ; and having continued above three hours, Velasquez de Leon, an impetuous and gallant young man, exclaimed with impatience, " Why waste more time in vain ? Let us either seize him instantly, or stab him to the heart." The threatening voice and fierce gestures with which these words were uttered, struck Montezuma. The Spaniards, he was sensible, had now proceeded so far, as left him no hope that they would recede. His own danger was imminent, the necessity unavoidable. He saw both ; and abandoning himself to his fate, complied with their request.

106
The emperor carried to the Spanish quarters.

His officers were called. He communicated to them his resolution. Though astonished and afflicted, they presumed not to question the will of their master, but carried him in silent pomp, all bathed in tears, to the Spanish quarters. When it was known that the strangers were conveying away the emperor, the people broke out into the wildest transports of grief and rage, threatening the Spaniards with immediate destruction, as the punishment justly due to their impious audacity. But as soon as Montezuma appeared with a seeming gaiety of countenance, and waved his hand, the tumult was hushed ; and upon his declaring it to be of his own choice that he went to reside for some time among his new friends, the multitude, taught to revere every intimation of their sovereign's pleasure, quietly dispersed.

The Spaniards at first pretended to treat Montezuma with great respect ; but soon took care to let him know that he was entirely in their power. Cortes wished that the shedding the blood of a Spaniard should appear the most heinous crime that could be committed ; and therefore not only took a most exemplary vengeance on those who had been concerned in the affair of Villa Rica, but even put the emperor himself in chains till the execution of the Mexican general was over. By these, and other insults, he at last gained entirely the ascendant over this unhappy monarch ; and he took care to improve his opportunity to the utmost. He sent his emissaries into different parts of the kingdom, accompanied with Mexicans of distinction, who might serve both to guide and to protect them. They visited most of the provinces, viewed their soil and productions, surveyed with particular care the districts which yielded gold or silver, pitched upon several places as proper for future colonies, and endeavoured to prepare the minds of the people for submitting to the Spanish yoke : and while they were thus employed, Cortes, in the name and by the authority of Montezuma, degraded some of the principal officers in the empire, whose abilities or independent

107
Cortes rules the empire.

spirit excited his jealousy ; and substituted in their place persons who he imagined would be more obsequious. One thing, however, was still wanting to complete his security. He wished to have such a command of the lake as might ensure a retreat, if, either from levity or disgust, the Mexicans should take arms against him, and break down the bridges or causeways, in order to inclose him in the city. In order to obtain this without giving disgust to the emperor or his court, Cortes artfully inflamed the curiosity of the Indians with accounts of the Spanish shipping, and those floating palaces that moved with such velocity on the water, without the assistance of oars ; and when he found that the monarch himself was extremely desirous of seeing such a novelty, he gave him to understand, that nothing was wanting to his gratification besides a few necessaries from Vera Cruz, for that he had workmen in his army capable of building such vessels. The bait took with Montezuma ; and he gave immediate orders that all his people should assist Cortes in whatever he should direct concerning the shipping. By this means, in a few days, two brigantines were got ready, full-rigged and equipped ; and Montezuma was invited on board, to make the first trial of their sailing, of which he could form no idea. Accordingly he embarked for this purpose, and gave orders for a great hunting upon the water, in order that all his people might be diverted with the novelty presented by the Spaniards. On the day appointed, the royal equipage was ready early in the morning ; and the lake was covered with a multitude of boats and canoes loaded with people. The Mexicans had augmented the number of their rowers on board the royal barges, with an intention to disgrace the Spanish vessels, which they regarded as clumsy, unwieldy, and heavy. But they were soon undeceived ; a fresh gale started up, the brigantines hoisted sail, to the utter astonishment of all the spectators, and soon left all the canoes behind ; while the monarch exulted in the victory of the Spaniards, without once considering that now he had effectually rivetted his own chains.

108
By a pretence, he obtains leave to build two brigantines on the lake.

Cortes having obtained this important point, resolved to put the condescension of the emperor to a trial still more severe. He urged Montezuma to acknowledge himself a vassal to the crown of Castile ; to hold his crown of him as superior, and to subject his dominions to the payment of an annual tribute. With this requisition, humiliating as it was, Montezuma complied. He called together the chief men of his empire, and, in a solemn harangue, reminded them of the traditions and prophecies which led them to expect the arrival of a people sprung from the same stock with themselves, in order to take possession of the supreme power ; he declared his belief that the Spaniards were this promised race ; and that therefore he recognised the right of their monarch to govern the Mexican empire, would lay his crown at his feet, and obey him as a tributary. While uttering these words, Montezuma discovered how deeply he was affected in making such a sacrifice. Tears and groans frequently interrupted his discourse. The first mention of such a resolution struck the assembly dumb with astonishment. This was followed by a sullen murmur of sorrow mingled with indignation ; which indicated some violent eruption of rage to be near at hand. This Cortes foresaw, and seasonably interposed to prevent it, by declaring that

109
Montezuma owns himself a vassal to the king of Spain.

Mexico. that his master had no intention to deprive Montezuma of the royal dignity, or to make any innovation upon the constitution and laws of the Mexican empire. This assurance, added to their dread of the Spanish arms, and the authority of their monarch's example, extorted the consent of the assembly; and the act of submission and homage was executed with all the formalities which the Spaniards pleased to prescribe.

110
The Spaniards divide their treasure.

Montezuma, at the request of Cortes, accompanied this profession of fealty and homage with a magnificent present to his new sovereign; and, after his example, his subjects brought in very liberal contributions. The Spaniards then collected all the treasure which had been either voluntarily bestowed upon them at different times by Montezuma, or had been extorted from his people under various pretences; and having melted the gold and silver, the value of these, without including jewels and ornaments of various kinds, which were preserved on account of their curious workmanship, amounted to 600,000 pesos. The soldiers were impatient to have it divided; and Cortes complied with their desire. A fifth of the whole was set apart as the tax due to the king. Another fifth was allowed to Cortes as commander. The sums advanced by the governor of Cuba, who had originally fitted out the expedition, were then deducted. The remainder was then divided among the army, including the garrison of Vera Cruz, in proportion to their different ranks; and after so many deductions, the share of a private man did not exceed 100 pesos. This sum fell so far below their sanguine expectations, that it required all the address, and no small exertions of the liberality of Cortes, to prevent an open mutiny. However, he at last restored tranquillity; but had no sooner escaped this danger, than he involved himself, by his imprudent zeal for religion, in one much worse. Montezuma, though often importuned, had obstinately refused to change his religion, or abolish the superstitious rites which had been for such a long time practised throughout his dominions. This at last transported the Spaniard with such rage, that, in a sally of zeal, he led out his soldiers in order to throw down the idols in the great temple by force. But the priests taking arms in defence of their altars, and the people crowding with great ardour to support them, Cortes's prudence over-ruled his zeal, and induced him to desist from his rash attempt, after dislodging the idols from one of the shrines, and placing in their stead an image of the Virgin Mary.

111
Cortes attempts to destroy the Mexican idols.

112
Which produces a general dissension.

113
The Spaniards are commanded to depart.

From this moment the Mexicans began to meditate the expulsion or the destruction of the Spaniards. The priests and leading men held frequent meetings with Montezuma for this purpose. But as any violent attempt might have proved fatal to the captive monarch, it was thought proper first to try more gentle means. Having called Cortes into his presence, he observed, that now, as all the purposes of his embassy were fully accomplished, the gods had declared their will, and the people signified their desire, that he and his followers should instantly depart out of the empire. With this he required them to comply, or unavoidable destruction would fall suddenly on their heads. This unexpected requisition, as well as the manner in which it was delivered, alarmed Cortes. However, he supposed

that more might be gained by a feigned compliance than by open resistance; and therefore replied with great composure, that he had already begun to prepare for his return; but as he had destroyed the vessels in which he arrived, some time was requisite for building other ships. This appeared reasonable; and a number of Mexicans were sent to Vera Cruz to cut down timber, and some Spanish carpenters were appointed to superintend the work.

Cortes flattered himself, that, during this interval, he might either find means to avert the threatened danger, or receive such reinforcements as would enable him to defend himself. Nine months had now elapsed since Portocarrero and Montejo had sailed with his dispatches to Spain; and he daily expected a return with a confirmation of his authority from the king, without which all that he had done served only to mark him out as an object of punishment. While he remained in great anxiety on this account, news were brought that some ships had appeared on the coast. These were imagined by Cortes to be a reinforcement sent him from Spain; but his joy was of short continuance, for a courier very soon arrived from Vera Cruz, with certain information that the armament was fitted out by Velasquez, the governor of Cuba; and instead of bringing succours, threatened them with immediate destruction.

Velasquez had been excited to this hostile measure chiefly through the indiscretion, or rather treachery, of the messengers of Cortes; who, contrary to his express injunctions, had landed on the island of Cuba, and given intelligence of all that had passed: and Velasquez, transported with rage at hearing of the proceedings of Cortes, had now sent against him this armament; consisting of 18 ships, which carried 80 horsemen, 800 infantry, of which 80 were musketeers, and 120 cross-bowmen, commanded by a brave officer named *Pamphilo de Narvaez*; whose instructions were, to seize Cortes and his principal officers, to send them prisoners to him, and then to complete the discovery and conquest of the country in his name. This proved a most afflicting piece of news to Cortes. However, thinking it imprudent to attempt any thing against his countrymen at first by force, he sent his chaplain Olmedo with proposals of accommodation. Narvaez rejected his proposals with scorn; but his followers were less violent in their resentments. Olmedo delivered many letters to them, either from Cortes himself, or from his officers their ancient friends and companions. These Cortes had artfully accompanied with presents of rings, chains of gold, and other trinkets of value; which inspired those needy adventurers with high ideas of the wealth he had acquired, and with envy of the good fortune of those who were engaged in his service. Some, from hopes of becoming sharers in these rich spoils, declared for an immediate accommodation; while others were for the same pacific measure, through fear of subverting the Spanish power entirely in a country where it was so imperfectly established. Narvaez disregarded both; and, by a proclamation, denounced Cortes and his adherents rebels and enemies to their country.

Cortes having now no resource but in war, left 150 men under the command of Pedro de Alvarado, an officer of great bravery, and much respected

Mexico.

114
An armament sent from Cuba against Cortes.

115
Which is defeated by that general.

Mexico. by the Mexicans, to guard the capital and the captive emperor; while he himself marched with the remainder, to meet his formidable opponent, who had taken possession of Zempoalla. Even after being reinforced by Sandoval his governor of Vera Cruz, the force of Cortes did not exceed 250 men. He hoped for success chiefly from the rapidity of his motions and the possibility of surprising his enemies; and as he chiefly dreaded their cavalry, he armed his soldiers with long spears, accustoming them to that deep and compact arrangement which the use of this formidable weapon enabled them to assume. As he advanced, however, he repeated his proposals of accommodation; but these being constantly rejected, and a price set upon his head, he at last attacked Narvaez in the night-time, entirely defeated and took him prisoner, obliging all his troops to own allegiance to himself.

116
Dangerous
situation of
the Spaniards left
at Mexico.

Nothing could be more seasonable than this victory, by which Cortes found his army very considerably increased; for most of the soldiers of Narvaez chose rather to follow Cortes than to return to Cuba, whither the conqueror had offered to send them if they chose. His affairs at Mexico, in the mean time, were in the utmost danger of being totally ruined; and had this decisive victory been delayed but a few days longer, he must have come too late to save his companions. A short time after the defeat of Narvaez, a courier arrived from Mexico with the disagreeable intelligence that the Mexicans had taken arms; and having seized and destroyed the two brigantines which he had built in order to secure the command of the lake, had attacked the Spaniards in their quarters, killed some, and wounded many more, burnt their magazine of provisions, and, in short, carried on hostilities with such fury, that though Alvarado and his men defended themselves with undaunted resolution, they must either be cut off by famine, or sink under the multitude of their enemies. This revolt was excited by motives which rendered it still more alarming. On the departure of Cortes for Zempoalla, the Mexicans flattered themselves, that the long-expected opportunity of restoring their sovereign to liberty, and driving out the Spaniards, was arrived; and consultations were accordingly held for bringing about both these events. The Spaniards in Mexico, conscious of their own weakness, suspected and dreaded these machinations; but Alvarado, who had neither the prudence nor the address of Cortes, took the worst method imaginable to overcome them. Instead of attempting to soothe or cajole the Mexicans, he waited the return of one of their solemn festivals, when the principal persons in the empire were dancing, according to custom, in the court of the great temple; he seized all the avenues which led to it; and, allured partly by the rich ornaments which they wore in honour of their gods, and partly by the facility of cutting off at once the authors of that conspiracy which he dreaded, he fell upon them, unarmed and unsuspecting of danger, and massacred a great number; none escaping but such as made their way over the battlements of the temple. An action so cruel and treacherous filled not only the city, but the whole empire, with indignation and rage; and the

Mexicans immediately proceeded in the manner above-mentioned. Mexico.

Cortes advanced with the utmost celerity to the relief of his distressed companions; but as he passed along, had the mortification to find that the Spaniards were generally held in abhorrence. The principal inhabitants had deserted the towns through which he passed; no person of note appeared to meet him with the usual respect; nor were provisions brought to his camp as usual. Notwithstanding these signs of aversion and horror, however, the Mexicans were so ignorant of the military art, that they again permitted him to enter the capital without opposition; though it was in their power to have easily prevented him, by breaking down the bridges and causeways which led to it.

Cortes was received by his companions with the utmost joy; and this extraordinary success so far intoxicated the general himself, that he not only neglected to visit Montezuma, but expressed himself very contemptuously concerning him. These expressions being reported among the Mexicans, they all at once flew to arms, and made such a violent and sudden attack, that all the valour and skill of Cortes were scarce sufficient to repel them. This produced great uneasiness among the soldiers of Narvaez, who had imagined there was nothing to do but to gather the spoils of a conquered country. Discontent and murmurings, however, were now of no avail; they were inclosed in an hostile city, and, without some extraordinary exertions, were inevitably undone. Cortes therefore, made a desperate sally; but, after exerting his utmost efforts for a whole day, was obliged to retire with the loss of 12 killed, and upwards of 60 wounded. Another sally was attempted with the like bad success, and in it Cortes himself was wounded in the hand.

The Spanish general was now thoroughly convinced of his error; and therefore betook himself to the only resource which was left; namely, to try what effect the interposition of Montezuma would have to soothe or overawe his subjects. When the Mexicans approached the next morning to renew the assault, that unfortunate prince, at the mercy of the Spaniards, and reduced to the sad necessity of becoming the instrument of his own disgrace, and of the slavery of his people, advanced to the battlements in his royal robes, and with all the pomp in which he used to appear on solemn occasions. At the sight of their sovereign, whom they had been long accustomed to reverence almost as a god, the Mexicans instantly forebore their hostilities, and many prostrated themselves on the ground: but when he addressed them in favour of the Spaniards, and made use of all the arguments he could think of to mitigate their rage, they testified their resentment with loud murmurings; and at length broke forth with such fury, that before the soldiers, appointed to guard Montezuma, had time to cover him with their shields, he was wounded with two arrows, and a blow on his temple with a stone struck him to the ground. On seeing him fall, the Mexicans instantly fled with the utmost precipitation: but the unhappy monarch, now convinced that he was become an object of contempt even to his own subjects, obstinately refused

117
Cortes allowed to
return to
Mexico;

118
But is furiously
attacked by
the natives.

119
Montezuma killed.

Mexico

120
A terrible
engage-
ment be-
tween the
Spaniards
and Mexi-
cans.

refused all nourishment; and thus in a short time ended his days.

On the death of Montezuma, Cortes having lost all hope of bringing the Mexicans to any terms of peace, prepared for retreat. But his antagonists, having taken possession of a high tower in the great temple, which overlooked the Spanish quarters, and placing there a garrison of their principal warriors, the Spaniards were so much exposed to their missile weapons, that none could stir without danger of being killed or wounded. From this post, therefore, it was necessary to dislodge them at any rate; and Juan de Escobar, with a large detachment of chosen soldiers, was ordered to make the attack. But Escobar, though a valiant officer, and though he exerted his utmost efforts, was thrice repulsed. Cortes, however, sensible that not only his reputation, but the safety of his army, depended on the success of this assault, caused a buckler to be tied to his arm, as he could not manage it with his wounded hand, and rushed with his drawn sword among the thickest of the combatants. Encouraged by the presence of their general, the Spaniards returned to the charge with such vigour, that they gradually forced their way up the steps, and drove the Mexicans to the platform at the top of the tower. There a dreadful carnage began; when two young Mexicans of high rank, observing Cortes, as he animated his soldiers, resolved to sacrifice their own lives in order to cut off the author of so many calamities which desolated their country. They approached him in a suppliant posture, as if they intended to lay down their arms; and seizing him in a moment, hurried him towards the battlements, over which they threw themselves headlong, in hopes of dragging him along with them. But Cortes, by his strength and agility, disengaged himself from their grasp; so that the two Mexicans perished alone.

As soon as the Spaniards became masters of the tower, they set fire to it, and without further molestation continued the preparations for their retreat. This became the more necessary, as their enemies, astonished at this last effort of their valour, had now entirely changed their system of hostility; and, instead of incessant attacks, endeavoured, by barricading the streets, and breaking down the causeways, to cut off the communication of the Spaniards with the continent, and thus to starve an enemy whom they could not subdue. The first point to be determined was, whether they should march out openly in the face of day, when they could discern every danger, or whether they should endeavour to retire secretly in the night. The latter was preferred, partly from hopes that the superstition of the Mexicans would prevent them from attacking them in the night, and partly from their own superstition in giving credit to the predictions of a private soldier, who pretended to astrology, and assured them of success if they retreated in this manner. Towards midnight, therefore, they began their march, in three divisions. Sandoval led the van; Pedro Alvarado and Velasquez de Leon had the conduct of the rear; and Cortes commanded in the centre, where he placed the prisoners, among whom were a son and two daughters of Montezuma, together with several Mexicans of distinction; the artillery, baggage, and a portable bridge of timber intended to be laid over

the breaches in the causeway. They marched in profound silence along the causeway which led to Tacuba, because it was shorter than any of the rest, and, lying most remote from the road towards Tlascala and the sea coast, had been left most entire by the Mexicans.

They reached the first breach in the causeway without molestation, hoping that their retreat was undiscovered. But the Mexicans had not only watched all their motions, but made preparations for a most formidable attack. While the Spaniards were intent upon placing their bridges in the breach, and occupied in conducting their horses and artillery along it, they were suddenly alarmed with the sound of warlike instruments, and found themselves assaulted on all sides by an innumerable multitude of enemies. Unfortunately the wooden bridge was wedged so fast in the mud by the weight of the artillery, that it was impossible to remove it. Dismayed at this accident, the Spaniards advanced with precipitation to the second breach. The Mexicans hemmed them in on every side; and though they defended themselves with their usual courage, yet, crowded as they were in a narrow causeway, their discipline and military skill were of little avail; nor did the obscurity of the night allow them to derive much advantage from their fire-arms or the superiority of their other weapons. At last the Spaniards, overborne with the numbers of their enemies, began to give way, and in a moment the confusion was universal. Cortes, with about 100 foot-soldiers, and a few horse, forced his way over the two remaining breaches in the causeway, the bodies of the dead serving to fill up the chasms, and reached the main land. Having formed them as soon as they arrived, he returned with such as were yet capable of service, to assist his friends in their retreat. He met with part of his soldiers who had forced their way through the enemy, but found many more overwhelmed by the multitude of their aggressors, or perishing in the lake; and heard the grievous lamentations of others whom the Mexicans were carrying off in triumph to be sacrificed to the god of war.

In this fatal retreat more than one half of Cortes's army perished, together with many officers of distinction. All the artillery, ammunition, and baggage, were lost; the greater part of the horses and above 2000 Tlascalans were killed, and only a very small part of their treasure saved. The first care of the Spanish general was to find some shelter for his wearied troops; for, as the Mexicans infested them on every side, and the people of Tacuba began to take arms, he could not continue in his present station. At last he discovered a temple seated on an eminence, in which he found not only the shelter he wanted, but some provisions; and though the enemy did not intermit their attacks throughout the day, they were without much difficulty prevented from making any impression. For six days after, they continued their march through a barren, ill cultivated, and thinly peopled country, where they were often obliged to feed on berries, roots, and the stalks of green maize; at the same time they were harassed without intermission by large parties of Mexicans, who attacked them on all sides. On the sixth day they reached Otumba, not far from the road between Mexico and Tlascala. Early next morning they

Mexico

121

Cortes retreats with great loss.

Mexico.

they began to advance towards it, flying parties of the enemy still hanging on their rear; and amidst the insults with which they accompanied their hostilities, Donna Marina remarked, that they often exclaimed with exultation, "Go on, robbers; go to the place where you shall quickly meet the vengeance due to your crimes." The meaning of this threat the Spaniards did not comprehend, until they reached the summit of an eminence before them. There a spacious valley opened to their view, covered with a vast army as far as the eye could reach. The Mexicans, while with one body of their troops they harassed the Spaniards in their retreat, had assembled their principal force on the other side of the lake; and marching along the road which led directly to Tlascala, posted it in the plain of Otumba, through which they knew Cortes must pass. At the sight of this incredible multitude, which they could survey at once from the rising ground, the Spaniards were astonished, and even the boldest began to despair. But Cortes, without allowing their fears time to operate, after warning them briefly that no alternative remained but to conquer or die, led them instantly to the charge. The Mexicans waited their approach with unusual fortitude: yet such was the superiority of the Spanish discipline and arms, that the impression of this small body was irresistible; and which ever way its force was directed, it penetrated and dispersed the most numerous battalions. But while these gave way in one quarter, new combatants advanced from another; and the Spaniards, though successful in every attack, were ready to sink under these repeated efforts, without seeing any end to their toil, or any hope of victory. At that time Cortes observed the great standard of the empire, which was carried before the Mexican general, advancing; and fortunately recollecting to have heard, that on the fate of it depended the event of every battle, he assembled a few of his bravest officers, whose horses were still capable of service, and, placing himself at their head, pushed towards the standard with such impetuosity that he bore down every thing before him. A chosen body of nobles, who guarded the standard, made some resistance, but were soon broken. Cortes, with a stroke of his lance, wounded the Mexican general, and threw him to the ground. One of his followers alighting, put an end to his life, and laid hold of the imperial standard. The moment that their leader fell, and the standard, towards which all directed their eyes, disappeared, an universal panic struck the Mexicans; and, as if the bond which held them together had been dissolved, every ensign was lowered, each soldier threw away his weapons, and fled with precipitation to the mountains. The Spaniards, unable to pursue them far, returned to collect the spoils of the field; and these were so valuable as to be some compensation for the wealth which they had lost in Mexico; for in the enemy's army were most of their principal warriors dressed out in their richest ornaments, as if they had been marching to assured victory.

123
Mexicans
defeated.

The day after this important action (being July 8th 1520), the Spaniards entered the Tlascalan territories, where they were received with the most cordial friendship. Cortes endeavoured to avail himself of this

disposition as much as possible; for which purpose he distributed among them the rich spoils taken at Otumba with such a liberal hand, that he made himself sure of obtaining from the republic whatever he should desire. He drew a small supply of ammunition, and two or three field-pieces, from his stores at Vera Cruz. He dispatched an officer of confidence with four ships of Narvaez's fleet to Hispaniola and Jamaica, to engage adventurers, and to purchase horses, gunpowder, and other military stores. And as he knew that it would be in vain to attempt the reduction of Mexico, unless he could secure the command of the lake, he gave orders to prepare, in the mountains of Tlascala, materials for building 12 brigantines, so that they might be carried thither in pieces, ready to be put together, and launched when he stood in need of their service. But, in the mean time, his soldiers, alarmed at the thoughts of being exposed to such calamities a second time, presented a remonstrance to their general, in which they represented the imprudence of attacking a powerful empire with his shattered forces, and formally required him to return back to Cuba. All the eloquence of Cortes could now only prevail with them to delay their departure for some time, when he promised to dismiss such as should desire it. However, this was only a pretence; for Cortes, in fact, had the conquest of Mexico as much at heart as ever. Without giving his soldiers an opportunity of cabaling, therefore, he daily employed them against the people of the neighbouring provinces, who had cut off some detachments of Spaniards during his misfortunes at Mexico; and by which, as he was constantly attended with success, his men soon resumed their wonted sense of superiority.

But all the efforts of Cortes could have been of little avail, had he not unexpectedly obtained a reinforcement of Spanish soldiers. The governor of Cuba, to whom the success of Narvaez appeared an event of infallible certainty, having sent two small ships after him with new instructions, and a supply of men and military stores, the officer whom Cortes had appointed to command on the coast artfully decoyed them into the harbour of Vera Cruz, seized the vessels, and easily persuaded the soldiers to follow the standard of a more able leader than him whom they were destined to join. Soon after, three ships of more considerable force came into the harbour separately. These belonged to an armament fitted out by Francisco de Garay, governor of Jamaica, who had long aimed at dividing with Cortes the glory and gain of annexing the empire of Mexico to the crown of Castile. They had, however, unadvisedly made their attempt on the northern provinces, where the country was poor, and the inhabitants fierce and warlike; so that, after a succession of disasters, they were now obliged to venture into Vera Cruz, and cast themselves upon the mercy of their countrymen; and here they also were soon persuaded to throw off their allegiance to their master, and to enlist with Cortes. About the same time a ship arrived from Spain, freighted by some private adventurers, with military stores; and the cargo was eagerly purchased by Cortes, while the crew, following the example of the rest, joined him at Tlascala.

From these various quarters, the army of Cortes was

Mexico.

124
Cortes receives an
unexpected
reinforcement.

was

Mexico.

Mexico.

125
He sets out
again for
Mexico.

was augmented with 180 men and 20 horses; by which means he was enabled to dismiss such of the soldiers of Narvaez as were most troublesome and discontented; after the departure of whom he still mustered 550 infantry, of whom 80 were armed with muskets or cross-bows, 40 horsemen, and nine pieces of artillery. At the head of these, with 10,000 Tlascalans and other friendly Indians, he began his march towards Mexico, on the 28th of December, six months after his fatal retreat from that city.

126
Preparations of the
Mexicans
for their
defence.

The Mexicans, in the mean time, had made the best preparations they could for opposing such a formidable enemy. On the death of Montezuma, his brother Quetzlavaca was raised to the throne; and he had an immediate opportunity of showing that he was worthy of their choice, by conducting in person those fierce attacks which obliged the Spaniards to retire from his capital. His prudence in guarding against the return of the invaders was equal to the spirit he had shown in driving them out. He repaired what the Spaniards had ruined in the city, strengthened it with such fortifications as his people could erect; and besides filling his magazines with the usual implements of war, gave directions to make long spears, headed with the swords and daggers which they had taken from the Spaniards, in order to annoy the cavalry. But in the midst of these preparations he was taken off by the small-pox; and Guatimozin, his nephew and son-in-law, raised to the throne.

As soon as Cortes entered the enemy's territories, he discovered various preparations to obstruct his progress. But his troops forced their way with little difficulty; and took possession of Tezeuco, the second city of the empire, situated on the banks of the lake, about 20 miles from Mexico. Here he determined to establish his head-quarters, as the most proper station for launching his brigantines, as well as for making his approaches to the capital. In order to render his residence there more secure, he deposed the cazique or chief, who was at the head of that community, under pretence of some defect in his title, and substituted in his place a person whom a faction of the nobles pointed out as the right heir of that dignity. Attached to him by this benefit, the new cazique and his adherents served the Spaniards with inviolable fidelity.

127
Cortes
makes
great pro-
gress.

As the construction of the brigantines advanced slowly under the unskilful hands of soldiers and Indians, whom Cortes was obliged to employ in assisting three or four carpenters who happened fortunately to be in his service, and as he had not yet received the reinforcement which he expected from Hispaniola, he was not in a condition to turn his arms directly against the capital. To have attacked a city so populous, so well prepared for defence, and in a situation of such peculiar strength, must have exposed his troops to inevitable destruction. Three months elapsed before the materials for constructing the brigantines were finished, and before he heard any thing with respect to the success of his negotiation in Hispaniola. This, however, was not a season of inaction to Cortes. He attacked successively several of the towns situated around the lake; and though all the Mexican power was exerted to obstruct his operations, he either compelled them to submit to the Spanish crown, or reduced them to ruins. Other towns he endeavoured to con-

ciliate by more gentle means; and though he could not hold any intercourse with the inhabitants but by the intervention of interpreters, yet, under all the disadvantage of that tedious and imperfect mode of communication, he had acquired such thorough knowledge of the state of the country, as well as of the dispositions of the people, that he conducted his negotiations and intrigues with astonishing dexterity and success. Most of the cities adjacent to Mexico were originally the capitals of small independent states; and some of them having been but lately annexed to the Mexican empire, still retained the remembrance of their ancient liberty, and bore with impatience the rigorous yoke of their new masters. Cortes having early observed symptoms of their disaffection, availed himself of this knowledge to gain their confidence and friendship. By offering with confidence to deliver them from the odious dominion of the Mexicans, and by liberal promises of more indulgent treatment if they would unite with him against their oppressors, he prevailed on the people of several considerable districts, not only to acknowledge the king of Castile as their sovereign, but to supply the Spanish camp with provisions, and to strengthen his army with auxiliary troops. Guatimozin, on the first appearance of defection among his subjects, exerted himself with vigour to prevent or to punish their revolt; but, in spite of his efforts, the spirit continued to spread. The Spaniards gradually acquired new allies; and with deep concern he beheld Cortes arming against his empire those very hands which ought to have been active in his defence, and ready to advance against the capital at the head of a numerous body of his own subjects.

While, by these various methods, Cortes was gradually circumscribing the Mexican power within such narrow limits that his prospect of overturning it seemed neither to be uncertain nor remote, all his schemes were well nigh defeated by a conspiracy against his own person, and which was discovered only a short time before it was to have been executed. Though many were concerned, Cortes did not think proper to punish any more than the principal ringleader, whom he caused immediately to be hanged; and then, without allowing them leisure to ruminate on what had happened, and as the most effectual means of preventing the return of a mutinous spirit, he determined to call forth his troops immediately to action. Fortunately a proper occasion for this occurred, without his seeming to court it. He received intelligence, that the materials for building the brigantines were at length completely finished, and waited only for a body of Spaniards to conduct them to Tezeuco. The command of this convoy, consisting of 200 foot-soldiers, 15 horsemen, and 2 field-pieces, he gave to Sandoval, who by the vigilance, activity, and courage, which he manifested on every occasion, was growing daily in his confidence, and in the estimation of his fellow-soldiers. The service was no less singular than important; the beams, the planks, the masts, the cordage, the sails, the iron-work, and all the infinite variety of articles requisite for the construction of 13 brigantines, were to be carried 60 miles over land, thro' a mountainous country, by people who were unacquainted with the ministry of domestic animals, or the aid of machines to facilitate any work of labour. The

Tlasc-

Mexico. Tlascalans furnished 8000 *Tamenes*, an inferior order of men destined for servile tasks, to carry the materials on their shoulders, and appointed 15,000 warriors to accompany and defend them. Sandoval made the disposition for their progress with great propriety, placing the *Tamenes* in the centre, one body of warriors in the front, another in the rear, with considerable parties to cover the flanks. To each of these he joined some Spaniards, not only to assist them in danger, but to accustom them to regularity and subordination. Parties of Mexicans frequently appeared hovering around them on the high grounds: but perceiving no prospect of success in attacking an enemy continually on his guard, and prepared to receive them, they did not venture to molest him; and Sandoval had the glory of conducting safely to Tezeuco a convoy on which all the future operations of his countrymen depended.

128
The Spaniards receive another reinforcement.

This was followed by another event of no less moment. Four ships arrived at Vera Cruz from Hispaniola, with 200 soldiers, 80 horses, two battering cannon, and a considerable supply of ammunition and arms. Elevated with observing that all his preparatory schemes, either for recruiting his own army or impairing the force of the enemy, had now produced their full effect, Cortes, impatient to begin the siege in form, hastened the launching of the brigantines. To facilitate this, he had employed a vast number of Indians, for two months, in deepening the small rivulet which runs by Tezeuco into the lake, and in forming it into a canal near two miles in length; and though the Mexicans, aware of his intentions, as well as of the danger which threatened them, endeavoured frequently to interrupt the labourers, or to burn the brigantines, the work was at last completed. On the 28th of April, all the Spanish troops, together with auxiliary Indians, were drawn up on the banks of the canal; and with extraordinary military pomp, heightened and rendered more solemn by the celebration of the most sacred rites of religion, the brigantines were launched. As they fell down the canal in order, Father Olmedo blessed them, and gave each its name. Every eye followed them with wonder and hope, until they entered the lake, when they hoisted their sails, and bore away before the wind. A general shout of joy was raised; all admiring that bold inventive genius, which, by means so extraordinary, that their success almost exceeded belief, had acquired the command of a fleet, without the aid of which Mexico would have continued to set the Spanish power and arms at defiance.

129
The city besieged.

Cortes determined to attack the city from three different quarters; from Tezeuco on the east side of the lake, from Tacuba on the west, and from Cuyocan towards the south. Those towns were situated on the principal causeways which led to the capital, and intended for their defence. He appointed Sandoval to command in the first, Pedro de Alvarado in the second, and Christoval de Olid in the third; allotting to each a numerous body of Indian auxiliaries, together with an equal division of Spaniards, who, by the junction of the troops from Hispaniola, amounted now to 86 horsemen, and 818 foot-soldiers; of whom 118 were armed with muskets or cross-bows. Their train of artillery consisted of three battering cannon, and 15 field-

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pieces. He reserved for himself, as the station of greatest importance and danger, the conduct of the brigantines, each armed with one of his small cannon, and manned with 25 Spaniards.

As Alvarado and Olid proceeded towards the posts assigned them, they broke down the aqueducts which the ingenuity of the Mexicans had erected for conveying water into the capital, and, by the distress to which this reduced the inhabitants, gave a beginning to the calamities which they were destined to suffer. Alvarado and Olid found the towns, of which they were ordered to take possession, deserted by their inhabitants, who had fled for safety to the capital, where Guatimozin had collected the chief force of his empire, as there alone he could hope to make a successful stand against the formidable enemies who were approaching to assault him.

The first effort of the Mexicans was to destroy the fleet of brigantines, the fatal effects of whose operations they foresaw and dreaded. Though the brigantines, after all the labour and merit of Cortes in forming them, were of inconsiderable bulk, rudely constructed, and manned chiefly with landmen, hardly possessed of skill enough to conduct them, they must have been objects of terror to a people unacquainted with any navigation but that of their lake, and possessed of no vessel larger than a canoe. Necessity, however, urged Guatimozin to hazard the attack; and hoping to supply by numbers what he wanted in force, he assembled such a multitude of canoes as covered the face of the lake. They rowed on boldly to the charge, while the brigantines, retarded by a dead calm, could scarcely advance to meet them. But as the enemy drew near, a breeze suddenly sprung up; in a moment the sails were spread, and the brigantines with irresistible impetuosity broke their feeble opponents, upset many canoes, and dissipated the whole armament with such slaughter, as convinced the Mexicans, that the progress of the Europeans in knowledge and arts rendered their superiority greater on this new element than they had hitherto found it by land.

From that time Cortes remained master of the lake; and the brigantines not only preserved a communication between the Spaniards in their different stations, though at considerable distance from each other; but were employed to cover the causeways on each side, and keep off the canoes, when they attempted to annoy the troops as they advanced towards the city. He formed the brigantines in three divisions, allotting one to each station, with orders to second the operations of the officer who commanded there. From all the three stations he pushed on the attack against the city with equal vigour; but in a manner so very different from that whereby sieges are conducted in regular war, as might appear no less improper than singular to persons unacquainted with his situation. Each morning his troops assaulted the barricades which the enemy had erected on the causeways, forced their way over the trenches which they had dug, and through the canals where the bridges were broken down, and endeavoured to penetrate into the heart of the city, in hopes of obtaining some decisive advantage, which might force the enemy to surrender, and terminate the war at once; but when the obstinate valour of the Mexicans rendered the efforts of the day ineffectual, the Spaniards retired

Mexico.

130
The Spaniards defeat the Mexicans, and become masters of the lake.

Mexico. in the evening to their former quarters. Thus their toil and danger were, in some measure, continually renewed, the Mexicans repairing in the night what the Spaniards had destroyed through the day, and recovering the posts from which they had driven them. But necessity prescribed this slow and untoward mode of operation. The number of his troops was so small, that Cortes durst not, with a handful of men, attempt to make a lodgment in a city where he might be surrounded and annoyed by such a multitude of enemies. The remembrance of what he had already suffered by the ill-judged confidence with which he had ventured into such a dangerous situation, was still fresh in his mind. The Spaniards, exhausted with fatigue, were unable to guard the various posts which they daily gained; and though their camp was filled with Indian auxiliaries, they durst not devolve this charge upon them, because they were so little accustomed to discipline, that no confidence could be placed in their vigilance. Besides this, Cortes was extremely solicitous to preserve the city as much as possible from being destroyed, both as he destined it to be the capital of his conquests, and wished that it might remain as a monument of his glory. From all these considerations, he adhered obstinately, for a month after the siege was opened, to the system which he had adopted. The Mexicans, in their own defence, displayed valour which was hardly inferior to that with which the Spaniards attacked them. On land, on water, by night and by day, one furious conflict succeeded to another. Several Spaniards were killed, more wounded, and all were ready to sink under the toils of unintermitting service, which were rendered more intolerable by the injuries of the season, the periodical rains being now set in with their usual violence.

Astonished and disconcerted with the length and difficulties of the siege, Cortes determined to make one great effort to get possession of the city before he relinquished the plan which he had hitherto followed, and had recourse to any other mode of attack. With this view, he sent instructions to Alvarado and Sandoval to advance with their divisions to a general assault, and took the command in person of that posted on the causeway of Cuyocan. Animated by his presence, and the expectation of some decisive event, the Spaniards pushed forward with irresistible impetuosity. They broke through one barricade after another, forced their way over the ditches and canals, and having entered the city, gained ground incessantly, in spite of the multitude and ferocity of their opponents. Cortes, though delighted with the rapidity of his progress, did not forget that he might still find it necessary to retreat; and in order to secure it, appointed Julian de Alderete, a captain of chief note in the troops which he had received from Hispaniola, to fill up the canals and gaps in the causeway as the main body advanced. That officer deeming it inglorious to be thus employed, while his companions were in the heat of action and the career of victory, neglected the important charge committed to him, and hurried on inconsiderately to mingle with the combatants. The Mexicans, whose military attention and skill were daily improving, no sooner observed this, than they carried an account of it to their monarch.

Guatimozin instantly discerned the consequences of
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the error which the Spaniards had committed, and, with admirable presence of mind, prepared to take advantage of it. He commanded the troops posted in the front to slacken their efforts, in order to allure the Spaniards to push forward, while he dispatched a large body of chosen warriors through different streets, some by land, and others by water, towards the great breach in the causeway, which had been left open. On a signal which he gave, the priests in the great temple struck the great drum consecrated to the god of war. No sooner did the Mexicans hear its doleful solemn sound, calculated to inspire them with contempt of death and with enthusiastic ardour, than they rushed upon the enemy with frantic rage. The Spaniards, unable to resist men urged on no less by religious fury than hope of success, began to retire, at first leisurely, and with a good countenance; but as the enemy pressed on, and their own impatience to escape increased, the terror and confusion became so general, that when they arrived at the gap in the causeway, Spaniards and Tlascalans, horsemen and infantry, plunged in promiscuously, while the Mexicans rushed upon them fiercely from every side, their light canoes carrying them through shoals which the brigantines could not approach. In vain did Cortes attempt to stop and rally his flying troops; fear rendered them regardless of his intreaties or commands.

131
Cortes re-
pulled in an
attack.
Finding all his endeavours to renew the combat fruitless, his next care was to save some of those who had thrown themselves into the water; but while thus employed, with more attention to their situation than to his own, six Mexican captains suddenly laid hold of him, and were hurrying him off in triumph; and though two of his officers rescued him at the expence of their own lives, he received several dangerous wounds before he could break loose. Above 60 Spaniards perished in the rout; and what rendered the disaster more afflicting, 40 of these fell alive into the hands of an enemy never known to shew mercy to a captive.

The approach of night, though it delivered the dejected Spaniards from the attacks of the enemy, ushered in, what was hardly less grievous, the noise of their barbarous triumph, and of the horrid festival with which they celebrated their victory. Every quarter of the city was illuminated; the great temple shone with such peculiar splendor, that the Spaniards could plainly see the people in motion, and the priests busy in hastening the preparations for the death of the prisoners. Through the gloom they fancied that they discerned their companions by the whiteness of their skins, as they were stripped naked and compelled to dance before the image of the god to whom they were to be offered. They heard the shrieks of those who were sacrificed, and thought they could distinguish each unhappy victim by the well-known sound of his voice. Imagination added to what they really saw or heard, and augmented its horror. The most unfeeling melted into tears of compassion, and the stoutest heart trembled at the dreadful spectacle which they beheld.

Cortes, who, besides all that he felt in common with his soldiers, was oppressed with the additional load of anxious reflections natural to a general on such an unexpected calamity, could not like them relieve his mind by giving vent to its anguish. He was obliged to assume an air of tranquillity in order to revive the spirits

Mexico.
 132
 The Mexi-
 cans renew
 the attack
 with great
 fury.

and hopes of his followers. The juncture, indeed, required an extraordinary exertion of fortitude. The Mexicans, elated with their victory, sallied out next morning to attack him in his quarters. But they did not rely on the efforts of their own arms alone: they sent the heads of the Spaniards whom they had sacrificed to the leading men in the adjacent provinces, and assured them that the god of war, appeased by the blood of their invaders, which had been shed so plentifully on his altars, had declared with an audible voice, that in eight days time those hated enemies should be finally destroyed, and peace and prosperity re-established in the empire.

A prediction, uttered with such confidence, and in terms so void of ambiguity, gained universal credit among a people prone to superstition. The zeal of the provinces which had already declared against the Spaniards augmented, and several which had hitherto remained inactive took arms with enthusiastic ardour to execute the decrees of the gods. The Indian auxiliaries who had joined Cortes, accustomed to venerate the same deities with the Mexicans, and to receive the responses of their priests with the same implicit faith, abandoned the Spaniards as a race of men devoted to certain destruction. Even the fidelity of the Tlascalans was shaken, and the Spanish troops were left almost alone in their stations. Cortes, finding that he attempted in vain to dispel the superstitious fears of his confederates by argument, took advantage, from the imprudence of those who had framed the prophecy in fixing its accomplishment so near at hand, to give them a striking demonstration of its falsity. He suspended all military operations during the period marked out by the oracle. Under cover of the brigantines, which kept the army at a distance, his troops lay in safety, and the fatal term expired without any disaster.

133
 Cortes ad-
 opts a more
 cautious
 method of
 proceeding.

His allies, ashamed of their own credulity, returned to their station. Other tribes, judging that the gods, who had now deceived the Mexicans, had decreed finally to withdraw their protection from them, joined his standard; and such was the levity of a simple people, moved by every slight impression, that, in a short time after such a general defection of his confederates, Cortes saw himself, if we may believe his own account, at the head of 150,000 Indians. Even with such a numerous army, he found it necessary to adopt a new and more wary system of operation. Instead of renewing his attempts to become master of the city at once, by such bold but dangerous efforts of valour as he had already tried, he made his advances gradually, and with every possible precaution against exposing his men to any calamity similar to that which they still bewailed. As the Spaniards pushed forward, the Indians regularly repaired the causeways behind them. As soon as they got possession of any part of the town, the houses were instantly levelled with the ground. Day by day, the Mexicans, forced to retire as their enemies gained ground, were hemmed in within more narrow limits. Guatimozin, though unable to stop the career of the enemy, continued to defend his capital with obstinate resolution, and disputed every inch of ground. But the Spaniards, having not only varied their mode of attack, but, by order of Cortes, having changed the weapons with which they fought, were again armed with the long Chinantlan spears,

which they had employed with such success against Narvaez; and, by the firm array in which this enabled them to range themselves, they repelled, with little danger, the loose assault of the Mexicans: incredible numbers of them fell in the conflicts, which they renewed every day. While war wasted without, famine began to consume them within the city. The Spanish brigantines, having the entire command of the lake, rendered it impossible to receive any supply of provisions by water. The vast number of his Indian auxiliaries enabled Cortes to shut up the avenues to the city by land. The stores which Guatimozin had laid up were exhausted by the multitudes which crowded into the capital to defend their sovereign and the temples of their gods. Not only the people, but persons of the highest rank, felt the utmost distresses of want. What they suffered brought on infectious and mortal distempers, the last calamity that visits besieged cities, and which filled up the measure of their woes.

But, under the pressure of so many and such various evils, the spirit of Guatimozin remained firm and unsubdued. He rejected with scorn every overture of peace from Cortes; and, disdaining the idea of submitting to the oppressors of his country, determined not to survive its ruin. The Spaniards continued their progress. At length all the three divisions penetrated into the great square in the centre of the city, and made a secure lodgment there. Three-fourths of the city were now reduced, and laid in ruins. The remaining quarter was so closely pressed, that it could not long withstand assailants who attacked it from their new station with superior advantage, and more assured expectation of success. The Mexican nobles, solicitous to save the life of a monarch whom they revered, prevailed on Guatimozin to retire from a place where resistance was now vain, that he might rouse the more distant provinces of the empire to arms, and maintain there a more successful struggle with the public enemy. In order to facilitate the execution of this measure, they endeavoured to amuse Cortes with overtures of submission, that, while his attention was employed in adjusting the articles of pacification, Guatimozin might escape unperceived. But they made this attempt upon a leader of greater sagacity and discernment than to be deceived by their arts. Cortes suspecting their intention, and, aware of what moment it was to defeat it, appointed Sandoval, the officer on whose vigilance he could most perfectly rely, to take the command of the brigantines, with strict injunctions to watch every motion of the enemy. Sandoval, attentive to the charge, observing some large canoes crowded with people rowing along the lake with extraordinary rapidity, instantly gave the signal to chase. Gracia Holguin, who commanded the fleetest brigantine, soon overtook them, and was preparing to fire on the foremost canoe, which seemed to carry some person whom all the rest followed and obeyed. At once the rowers dropt their oars, and all on board, throwing down their arms, conjured him with cries and tears to forbear, as the emperor was there. Holguin eagerly seized his prize; and Guatimozin, with a dignified composure, gave himself up into his hands, requesting only that no insult might be offered to the empress or his children. When conducted to Cortes, he

134
 Guatimozin refused to submit on any terms.

135
 He is taken prisoner.

Mexico.

he appeared neither with the sullen fierceness of a barbarian, nor with the dejection of a suppliant. "I have done," said he, addressing himself to the Spanish general, "what became a monarch. I have defended my people to the last extremity. Nothing now remains but to die. Take this dagger," laying his hand on one which Cortes wore, "plant it in my breast, and put an end to a life which can no longer be of use."

136
Mexico
submits.

As soon as the fate of their sovereign was known, the resistance of the Mexicans ceased; and Cortes took possession of that small part of the capital which yet remained undestroyed. Thus terminated the siege of Mexico, the most memorable event in the conquest of America. It continued 75 days, hardly one of which passed without some extraordinary effort of one party in the attack, or of the other in the defence of a city, on the fate of which both knew that the fortune of the empire depended. As the struggle here was more obstinate, it was likewise more equal, than any between the inhabitants of the Old and New Worlds. The great abilities of Guatimozin, the number of his troops, the peculiar situation of his capital, so far counterbalanced the superiority of the Spaniards in arms and discipline, that they must have relinquished the enterprise, if they had trusted for success to themselves alone. But Mexico was overturned by the jealousy of neighbours who dreaded its power, and by the revolt of subjects impatient to shake off its yoke. By their effectual aid, Cortes was enabled to accomplish what, without such support, he would hardly have ventured to attempt. How much soever this account of the reduction of Mexico may detract, on the one hand, from the marvellous relations of some Spanish writers, by ascribing that to simple and obvious causes which they attribute to the romantic valour of their countrymen, it adds, on the other, to the merit and abilities of Cortes, who, under every disadvantage, acquired such an ascendant over unknown nations, as to render them instruments towards carrying his scheme into execution.

The exultation of the Spaniards, on accomplishing this arduous enterprise, was at first excessive. But this was quickly damped by the cruel disappointment of those sanguine hopes which had animated them amidst so many hardships and dangers. Instead of the inexhaustible wealth which they expected from becoming masters of Montezuma's treasures, and the ornaments of so many temples, their rapaciousness could collect only an inconsiderable booty amidst ruins and desolation (A). Guatimozin, aware of his impending fate, had ordered what remained of the riches amassed by his ancestors to be thrown into the lake. The Indian auxiliaries, while the Spaniards were engaged in conflict with the enemy, had carried off the most valuable part of the spoil. The sum to be divided among the conquerors was so small, that many of them disdained to accept of the pittance which fell to their share, and all murmured and exclaimed; some against Cortes and his confidants, whom they suspected of having secretly appropriated to their own use a large portion of

the riches which should have been brought into the common stock; others against Guatimozin, whom they accused of obstinacy, in refusing to discover the place where he had hidden his treasure.

Arguments, intreaties, and promises, were employed in order to soothe them; but with so little effect, that Cortes, from solicitude to check this growing spirit of discontent, gave way to a deed which stained the glory of all his great actions. Without regarding the former dignity of Guatimozin, or feeling any reverence for those virtues which he had displayed, he subjected the unhappy monarch, together with his chief favourite, to torture, in order to force from them a discovery of the royal treasures, which it was supposed they had concealed. Guatimozin bore whatever the refined cruelty of his tormentors could inflict, with the invincible fortitude of an American warrior. His fellow-sufferer, overcome by the violence of the anguish, turned a dejected eye towards his master, which seemed to implore his permission to reveal all that he knew. But the high-spirited prince, darting on him a look of authority mingled with scorn, checked his weakness, by asking, "Am I now reposing on a bed of flowers?" Overawed by the reproach, he persevered in his dutiful silence, and expired. Cortes, ashamed of a scene so horrid, rescued the royal victim from the hands of his torturers, and prolonged a life reserved for new indignities and sufferings.

Mexico.

137
Guatimo-
zin tortu-
red.

The fate of the capital, as both parties had foreseen, decided that of the empire. The provinces submitted one after another to the conquerors. Small detachments of Spaniards marching through them without interruption, penetrated, in different quarters, to the great Southern Ocean, which, according to the ideas of Columbus, they imagined would open a short as well as easy passage to the East Indies, and secure to the crown of Castile all the envied wealth of those fertile regions; and the active mind of Cortes began already to form schemes for attempting this important discovery. In his after schemes, however, he was disappointed; but Mexico hath ever since remained in the hands of the Spaniards.

138
The Spaniards become masters of the whole Mexican empire.

The ancient kingdom of Mexico, properly so called, was divided into several provinces, of which the vale of Mexico itself was the finest in every respect. It is surrounded by verdant mountains, measuring upwards of 120 miles in circumference at their base. A great part of this vale is occupied by two lakes, the upper one of fresh water, but the lower one brackish, communicating with the former by means of a canal. All the water running from the mountains is collected in this lower lake, on account of its being in the bottom of the valley; hence it was ready, when swelled by extraordinary rains, to overflow the city of Mexico, as has already been observed. This delightful region contained the three imperial cities of Mexico, Acolhuacan, and Tlacopan; besides 40 others, with innumerable villages and hamlets; but the most considerable of these, according to Clavigero, now scarcely retain one-twentieth part of their former magnificence. The principal inland provinces to the northward were

139
Ancient divisions of Mexico.

4 P 2

the

(A) The gold and silver, according to Cortes, amounted only to 120,000 pesos, Relat. 280, A. a sum far inferior to that which the Spaniards had formerly divided in Mexico.

Mexico. the Otomies; to the south-west the Malatzincas and Cuitlatecas; to the south the Tlahuicas and Cohuixcas; to the south-east, after the states of Itzocan, Jauhtepac, Quauhquecollon, Atlixco, Tehuacan, and others, were the great provinces of the Mixtecas, the Zapotecas, and the Chiapanecas; towards the east were the provinces of Tepayacac, the Popolocas, and Totonacas. The maritime provinces on the Mexican Gulf were Coatzacualco and Cuertlachtlan, called by the Spaniards *Cotafila*. On the Pacific Ocean were those of Coliman, Zacatollan, Tototepec, Tecuantepec, and Zoconochco.

The province of the Otomies began in the northern part of the vale of Mexico, extending through the mountains to the north to the distance of 90 miles from the city of Mexico; the principal cities being Tollan or Tula, and Xilotepec: the latter made the capital of the country by the Spaniards. Beyond the settlements of the Otomies, the country for more than a thousand miles in extent was inhabited only by barbarous and wandering savages.

The Malatzinca province contained the valley of Tolocan, and all the country from *Taximaroa* to the frontier of the kingdom of Michuacan. The valley of Tolocan is upwards of 40 miles long from south-east to north-west, and 30 in breadth where broadest. Its principal city, named also *Tolocan*, is situated at the foot of a high mountain covered with snow, 30 miles distant from Mexico.

The country of the Cuitlatecas extended from north-east to south-west, upwards of 200 miles, extending as far as the Pacific Ocean. Their capital was named Mexcaltepec, once a great and populous city, situated upon the sea-coast; but of which the ruins are now scarcely visible. That of the Tlahuicas was named Quauhnhuac, and situated about 40 miles to the southward of Mexico. The province extended almost 60 miles southward, commencing from the southern mountains of the vale of Mexico.

The country of the Cohuixcas extended on the southward as far as the Pacific Ocean, through that part where at present the port and city of Acapulco lie. It was divided into the states of Tzompanco, Chilapan, Tlapan, and Tistla; the latter a very hot and unwholesome country. To this province belonged a place named *Tlachco*, celebrated for its silver-mines.

The province of the Mixtecas extended from *Acatlan*, a place distant about 120 miles from Mexico, as far as the Pacific Ocean towards the south-east. The inhabitants carried on a considerable commerce, and had several well inhabited cities and villages. To the east of the Mixtecas were the Zapotecas, so called from their capital Teotzapotlan. In their district was the valley of Huaxyacac, now Oaxaca or Guaxaca.

The province of Mazatlan lay to the northward of the Mixtecas; and to the northward and eastward of the Zapotecas was *Ghimantla*, having their capitals of the same name with their provinces. The Chiapanecas, Zoqui, and Queleni, were the last of the Mexican provinces towards the south-east. On the side of the mountain Popocatepec and around it lay several states, of which the most considerable were Cholallan and Huexotzinco. These two having, with the assistance of the Tlascalans, shaken off the Mexican yoke, re-esta-

Mexico. blished their former aristocratical government. The Cholulans possessed a small hamlet called Cuitlaxcoapan, in the place where the Spaniards afterwards founded the city of Angelopoli, which is the second of New Spain.

To the eastward of Cholula lay a considerable state named Tepeyacac; and beyond that the Popolocas, whose principal cities were Tecamachalco and Quecholac. To the southward of the Popolocas was the state of Tahuacan, bordering upon the country of the Mixtecas; to the east, the maritime province of Cuertlachtlan; and to the north the Totonacas. The extent of this province was 150 miles, beginning from the frontier of Zacatlan, a state distant about 80 miles from the court, and terminating in the Gulf of Mexico. Besides the capital, named *Mizquihuacan*, this country had the beautiful city of Chempoallan, situated on the coast of the Gulf; remarkable for being that by which the Spaniards entered the Mexican empire.

Coliman was the most northerly of the provinces on the Pacific Ocean; the capital, named also Coliman, being in lat. 19. long. 272. Towards the south-east was the province of Zacatlan, with its capital of the same name; then came the coast of the Cuitlatecas; after it that of the Cohuixcas, in which was the celebrated port of Acapulco. The *Jopi* bordered on the Cohuixca coast; and adjoining to that the Mixteca country, now called *Xicayan*; next to that was the large province of Tecuantepec; and lastly, that of Xochonochco.

This province, the most southerly of the Mexican empire, was bounded on the east and south-east by the country of Xochitepec, which did not belong to Mexico; on the west by Tecuantepec; and on the south by the ocean. The capital, called also *Xoconochco*, was situated between two rivers, in 14 degrees of latitude and 283 of longitude. On the Mexican Gulf there were, besides the country of the Totonecas, the provinces of Cuertlachtlan and Coatzacualco; the latter bounded on the east by the states of Tabasco and the peninsula of Yucatan. The province of Cuertlachtlan comprehended all the coast between the rivers Alvarado and Antigua, where the province of the Totonecas began.

The climate of this vast country varies very much according to the situation of its different parts. The maritime places are hot, unhealthy, and moist; the heat being so great as to cause people sweat even in the month of January. This heat is supposed to be owing to the flatness of the coasts, and the accumulation of sand upon them. The moisture arises from the vast evaporation from the sea, as well as from the great torrents of water descending from the mountains. The lands which lie in the neighbourhood of high mountains, the tops of which are always covered with snow, must of necessity be cold; and Clavigero informs us, that he has been on a mountain not more than 25 miles distant from the city of Mexico, where there was white frost and ice even in the dog-days. "All the other inland countries (says our author), where the greatest population prevailed, enjoy a climate so mild and benign, that they neither feel the rigour of winter nor the heats of summer. It is true, in many of these countries, there is frequently white frost

140°
Climate.

Mexico. in the three months of December, January, and February, and sometimes even it snows; but the small inconvenience which such cold occasions continues only till the rising sun: no other fire than his rays is necessary to give warmth in winter; no other relief is wanted in the season of heat but the shade: the same clothing which covers men in the dog-days defends them in January, and the animals sleep all the year under the open sky.

141
Causes of
mildness of
the climate.

"This mildness and agreeableness of climate under the torrid zone is the effect of several natural causes entirely unknown to the ancients, who did not believe it to be inhabited; and not well understood by some moderns, by whom it is believed unfavourable to those who live in it. The purity of the atmosphere, the smaller obliquity of the solar rays, and the longer stay of this luminary above the horizon in winter, in comparison of other regions farther removed from the equator, concur to lessen the cold, and to prevent all that horror which disfigures the face of nature in other climes. During that season a serene sky and the natural delights of the country are enjoyed; whereas, under the frigid, and even for the most part under the temperate zones, the clouds rob man of the prospect of heaven, and the snow buries the beautiful productions of the earth. No less causes combine to temper the heat of summer. The plentiful showers which frequently water the earth after mid-day from April or May to September or October; the high mountains, continually loaded with snow, scattered here and there through the country of Anahuac; the cool winds which breathe from them in that season; and the shorter stay of the sun above the horizon, compared with the circumstances of the temperate zone, transform the climes of those happy countries into a cool and cheerful spring. But the agreeableness of the climate is counterbalanced by thunder-storms, which are frequent in summer, particularly in the neighbourhood of the mountain of Tlascala; and by earthquakes, which are at all times felt, though with less danger than terror. Storms of hail are neither more frequent nor more severe than in Europe."

142
Mexican
volcanoes.

One undoubted inconvenience which Mexico has is that of volcanoes, of which our author enumerates five. One named by the Spaniards *Volcan d'Orizaba* is higher than the peak of Teneriffe, according to the account of the Jesuit Tallandier, who measured them both. It began to send forth smoke in the year 1545; and continued burning for 20 years, but has not discovered any symptoms of eruption since that time. It is of a conical figure; and, by reason of its great height, may be seen at 50 leagues distance. The top is always covered with snow, but the lower part with woods of pine and other valuable timber. It is about 90 miles to the eastward of the capital.

Two other mountains, named *Popocatepec* and *Iztaccibuatl*, which lie near each other, at the distance of 33 miles to the south-east of Mexico, are likewise surprisingly high. Clavigero supposes the former to be higher than the highest of the Alps, considering the elevated ground on which the base of it stands. It has a crater more than half a mile wide; from which, in the time of the Mexican kings, great quantities of smoke and flame issued. In the last century it frequently threw out great showers of ashes

upon the adjacent places; but in this century hardly any smoke has been observed. This mountain is named by the Spaniards *Volcan*, and the other *Sierra Nevada*. The latter has also sometimes emitted flames. Both of them have their tops always covered with snow in such quantities, that the masses which fall down upon the neighbouring rocks supply the cities of Mexico, Gelopoli, Cholula, and all the adjacent country to the distance of 40 miles, with that commodity; of which the consumpt is so great, that in 1746 the impost upon what was consumed in the city of Mexico amounted to 15,222 Mexican crowns; some years after it amounted to 20,000; and is now in all probability a great deal more. Besides these, there are the two mountains of Coliman and Tochtlan, both of which have occasionally emitted flames. Our author does not include in the list of Mexican volcanoes either those of Nicaragua or Guatemala; because these countries were not subject to the Mexican sovereigns. Those of Guatemala sometimes break forth in a most furious manner, and in the year 1773 entirely destroyed that beautiful city. The Nicaraguan volcano called *Juruyo* was only a small hill before the year 1760. In that year, however, on the 29th of September, it began to burn with furious explosions, ruining entirely the sugar-work and the neighbouring village of *Guacana*; and from that time continued to emit fire and burning rocks in such quantities, that the erupted matters in six years had formed themselves into three high mountains nearly six miles in circumference. During the time of the first eruption, the ashes were carried as far as the city of Queretaro, 150 miles distant from the volcano; and at Valladolid, distant 60 miles from it, the shower was so abundant, that the people were obliged to sweep the house-yards two or three times a-day.

Besides these volcanoes, there are others in Mexico of a very remarkable height. The great chain of mountains called the *Andes* are continued through the isthmus of Panama and through all Mexico, until they are lost in the unknown mountains of the north. The most considerable of that chain is known in Mexico by the name of *Sierra Madre*, particularly in Cinaloa and Tarahumara, provinces no less than 1200 miles distant from the capital.

Mexico is well watered by very considerable rivers, though none of them are comparable to those of South America. Some of these run into the gulf of Mexico, and others into the Pacific Ocean. The Alvarado has its principal source among the mountains of the Zapotecas, and discharges itself by three navigable mouths into the Mexican gulf, at the distance of 30 miles from Vera Cruz. The Coatzacoalco rises among the mountains of the Mixtecas, and empties itself into the gulf near the country of Onohualco. The river Chiapan, which likewise runs into this gulf, rises among the mountains which separate the district of Chiapan from that of Guatemala. The Spaniards call this river *Tabasco*; by which name they also called that tract of land which unites Yucatan to the Mexican continent. It was also called the *Grijalva*, from the name of the commander of the first Spanish fleet who discovered it.

The most celebrated of the rivers which run into the Pacific Ocean is that called by the Spaniards

Mexico.

143
Rivers and
lakes.

Gau-

Mexico. *Guadalaxara* or *Great River*. It rises in the mountains of Toloccan; and after running a course of more than 600 miles, discharges itself into the ocean in 22° latitude.

There are likewise in this country several lakes of very considerable magnitude; but those of Nicaragua, Chapallan, and Pazquaro, which are of the greatest extent, did not belong to the ancient Mexican empire. The most remarkable were those in the vale of Mexico, upon which the capital of the empire was founded. Of these, the fresh water one called the *lake of Chalco*, extended in length from east to west 12 miles, as far as the city of Xochimilco; from thence, taking a northerly direction, it incorporated itself by means of a canal with the lake of Tezcucó; but its breadth did not exceed six miles. The other, named the *lake of Tezcucó*, extended 15, or rather 17, miles from east to west, and something more from south to north; but its extent is now much less, by reason of the Spaniards having diverted the course of many of the streams which run into it. This lake is salt, which Clavigero supposes to arise from the nature of the soil which forms its bed.

Besides these, there are a number of smaller lakes, some of which are very delightful. There is a vast variety of mineral waters, of the nitrous, sulphureous, and aluminous kinds, some of them so hot that meat might be boiled in them. At Tetuhuacan is a kind of petresying water, as well as in several other parts of the empire. One of them forms a kind of smooth white stones, not displeasing to the taste; the scrapings of which taken in broth are celebrated as a diaphoretic, probably without any good reason. The dose for a person not difficult to be sweated is one drachm of the scrapings. Many of the rivers of Mexico afford surprising and beautiful cascades; particularly the great river *Guadalaxara*, at a place called *Tempizque*, 15 miles to the southward of that city. Along a deep river called *Atoyaque* is a natural bridge, consisting of a vast mound of earth, along which carriages pass conveniently. Clavigero supposes it to have been the fragment of a mountain thrown down by an earthquake, and then penetrated by the river.

144
Metals and
minerals.

The mineral productions of Mexico are very valuable. The natives found gold in several provinces of the empire. They gathered it principally from among the sands of their rivers in grains; and the people in whose country it was found, were obliged to pay a certain quantity by way of tribute to the emperor. They dug silver out of mines in Tlocho, and some other countries, but it was less prized by them than by other nations. Since the conquest, however, so many silver mines have been discovered in that country, especially in the provinces to the northwest of the capital, that it is in vain to attempt any enumeration of them. They had two sorts of copper: one hard, which served them instead of iron, to make axes and other instruments for war and agriculture; the other kind, which was soft and flexible, served for domestic utensils as with us. They had also tin from the mines of Tlachco, and dug lead out of mines in the country of the Otomies; but we are not informed what uses they put this last metal to. They had likewise mines of iron in Tlascala, Tlachco, and some other places; but these were either unknown to

the Mexicans, or they did not know how to benefit themselves by them. In Chilapan were mines of quicksilver; and in many places they had sulphur, alum, vitriol, cinnabar, ochre, and an earth greatly resembling white lead. These minerals were employed in painting and dyeing; but we know not to what use they put their quicksilver. There was great abundance of amber and asphaltum upon their coasts; both of which were paid in tribute to the king of Mexico from many parts of the empire. The former was wont to be set in gold by way of ornament, and asphaltum was employed in their sacrifices.

Mexico produces some diamonds, though but few ¹⁴⁵ in number; but they had in greater plenty some ^{Precious} other precious stones, such as amethysts, cats-eyes, turquoises, cornelians, and some green stones resembling emeralds, and very little inferior to them; of all which a tribute was paid to the emperor by the people in whose territories they were found. They were likewise furnished with crystal in plenty from the mountains which lay on the coast of the Mexican gulph, between the port of Vera Cruz and the river Coatzacoalco. In the mountains of Celpolalpan, to the eastward of Mexico, were quarries of jasper and marble of different colours: they had likewise alabaster at a place called *Tecalco*, now *Tecale*, in the neighbourhood of the province of Tapeyacac and many other parts of the empire. The stone tetzontli is generally of a dark red colour, pretty hard, porous, and light, and unites most firmly with lime and sand; on which account it is of great request for buildings in the capital, where the foundation is bad. There are entire mountains of loadstone, a very considerable one of which lies between Teoitztlán and Chilapan, in the country of the Coahuilcas. They formed curious figures of nephritic stone, some of which are still preserved in European museums. They had a kind of fine white talc which burnt into an excellent plaster, and with which they used to whiten their paintings. But the most useful stone they had was that called *itzli*, of which there is great abundance in many parts of Mexico. It has a glossy appearance, is generally of a black colour, and semitransparent; though sometimes also of a blue or white colour. In South America this stone is called *pietra del galinazzo*; and Count Caylus endeavours to show, in a manuscript dissertation quoted by Bomare, that the *obsidiana*, of which the ancients made their *vases murini*, were entirely similar to this stone. The Mexicans made of it looking-glasses, knives, lancets, razors, and spears. Sacred vases also were made of it after the introduction of Christianity.

The soil of Mexico, though various, produced every ¹⁴⁶ where the necessities and even the luxuries of life. ^{Vegetable} productions. "The celebrated Dr Hernandez, the Pliny of New Spain (says Clavigero), has described in his Natural History about 1200 plants natives of the country; but his description, though large, being confined to medicinal plants, has only comprised one part of what provident nature has produced there for the benefit of mortals. With regard to the other classes of vegetables, some are esteemed for their flowers, some for their fruit, some for their leaves, some for their root, some for their trunk or their wood, and others for their gum, resin, oil, or juice."

Mexico

¹⁴⁷
Mexico. Flowers and Fruits. Mexico abounds with a great variety of flowers, many of which are peculiar to the country, while multitudes of others imported from Europe and Asia rival in luxuriance the natives of the country itself. The fruits are partly natives of the Canary islands, partly of Spain, besides those which grow naturally in the country. The exotics are water-melons, apples, pears, peaches, quinces, apricots, pomegranates, figs, black cherries, walnuts, almonds, olives, chestnuts, and grapes; though these last are likewise natives. There are two kinds of wild vine found in the country of the Mixtecas; the one resembling the common vine in the shoots and figure of its leaves. It produces large red grapes covered with an hard skin, but of sweet and grateful taste, which would undoubtedly improve greatly by culture. The grape of the other kind is hard, large, and of a very harsh taste, but they make an excellent conserve of it. Our author is of opinion that the cocoa tree, plantain, citron, orange, and lemon, came from the Philippine islands and Canaries; but it is certain that these, as well as other trees, thrive in this country as well as in their native soil. All the maritime countries abound with cocoa-nut trees; they have seven kinds of oranges and four of lemons, and there are likewise four kinds of plantains. The largest, called the *zapalat*, is from 15 to 20 inches long, and about three in diameter; it is hard, little esteemed, and only eat when roasted or boiled. The *platano largo*, or "long plantain," is about eight inches long and one and a half in diameter; the skin is at first green, and blackish when perfectly ripe. The *guinco* is a smaller fruit, but richer, softer, and more delicious, though not so wholesome. A species of plantain, called the *dominico*, is smaller and more delicate than the others. There are whole woods of plantain trees, oranges, and lemons; and the people of Michuacan carry on a considerable commerce with the dried plantains, which are preferable either to raisins or figs. Clavigero enumerates 28 different sorts of fruit natives of Mexico, besides many others, the names of which are not mentioned. Hernandez mentions four kinds of cocoa nuts; of which the smallest of the whole was in most use for chocolate and other drinks daily made use of; the other kinds served rather for money in commerce than for aliment. The cocoa was one of the plants most cultivated in the warm countries of the empire; and many provinces paid it in tribute to the emperor, particularly that of Xoconochco, the cocoa nut of which is preferable to the others. Cotton was one of the most valuable productions of the country, as it served instead of flax; though this last also was produced in the country. It is of two kinds, white and tawny-coloured. They made use of *rocou* or Brasil-wood in their dying, as the Europeans also do. They made cordage of the bark, and the wood was made use of to produce fire by friction.

¹⁴⁸
Grain. The principal grain of Mexico, before the introduction of those from Europe, was maize, in the Mexican language called *tluolli*; of which there were several kinds, differing in size, weight, colour, and taste. This kind of grain was brought from America to Spain, and from Spain to the other countries of Europe. The French bean was the principal kind of pulse in use among them, of which there were more species than of the maize. The largest was called Mexico, *ayacotli*, of the size of a common bean, with a beautiful red flower; but the most esteemed was the small, black, heavy, French bean. This kind of pulse, which is not good in Italy, is in Mexico so excellent, that it not only serves for sustenance to the poorer class of people, but is esteemed a luxury even by the Spanish nobility.

¹⁴⁹
Esculent roots. Of the esculent roots of Mexico, the following were the most remarkable. 1. The *xicama*, called by the Mexicans *catzotl*, was of the figure and size of an onion; solid, fresh, juicy, and of a white colour; it was always eat raw. 2. The *camote*, is another very common in the country, of which there are three sorts, white, yellow, and purple: they eat best when boiled. 3. The *cacomite*, is the root of a plant which has a beautiful flower called the *tyger-flower*, with three red pointed petals, the middle part mixed with white and yellow, somewhat resembling the spots of the creature whence it takes its name. 4. The *huacamote*, is the root of a kind of Cassava plant, and is likewise boiled. 5. The *papa*, a root transplanted into Europe, and greatly valued in Ireland, was brought from South America into Mexico. Besides all which they have a number of kitchen vegetables imported from the Canaries, Spain, and other countries of Europe. The American aloe is very similar to the real one, and is a plant of which the Mexicans formerly, and the Spaniards still, make great use.

¹⁵⁰
Trees. They have a variety of palm trees. From the fibres of the leaves of one species they make thread. The bark of another kind, to the depth of three fingers, is a mass of membranes, of which the poor people make mats. The leaves of another kind are used for ornaments in their festivals. They are round, gross, white, and shining; having the appearance of shells heaped upon one another. A fourth kind bears nuts called *cocoas*, or nuts of oil. These nuts are of the size of a nutmeg, having in the inside a white, oily, eatable kernel, covered by a thin, purple, pellicle. The oil has a sweet scent, but is easily condensed, when it becomes a soft mass, as white as snow.

Of timber trees there are great variety, of a quality not inferior to any in the world; and as there are a variety of climates in the country, every one produces a kind of wood peculiar to itself. There are whole woods of cedars and ebonies, vast quantities of agallochum or wood of aloes; besides others valuable on account of their weight, durability, and hardness; or for their being easily cut, pliable, of a fine colour, or an agreeable flavour. There are also in Mexico innumerable trees remarkable for their size. Acosta mentions a cedar, the trunk of which was 16 fathoms in circumference; and Clavigero mentions one of the length of 107 Paris feet. In the city of Mexico he mentions very large tables of cedar made out of single planks. In the valley of Atlixco is a very ancient fir tree, hollowed by lightning; the cavity of which could conveniently hold fourteen horsemen; nay, we are informed by the archbishop of Toledo, that, in 1770, he went to view it along with the archbishop of Guatemala, at which time he caused an hundred young lads enter its cavity. Our author mentions some other trees, of the species called *ceibas*, which for magnitude may be compared with this celebrated

Mexico. celebrated fir. "The largeness of these trees (says he) is proportioned to their prodigious elevation; and they afford a most delightful prospect at the time they are adorned with new leaves and loaded with fruit, in which there is inclosed a particular species of fine, white, and most delicate cotton. This might be, and actually has been, made into webs as soft, delicate, and perhaps more so than silk; but it is toilsome to spin, on account of the smallness of the threads, and the profit does not requite the labour, the web not being lasting. Some use it for pillows and matrasles, which have the singular property of expanding enormously when exposed to the heat of the sun. De Bommare says, that the Africans make of the thread of the ceiba that vegetable taffety which is so scarce, and so much esteemed in Europe. The scarcity of such cloth is not to be wondered at considering the difficulty of making it. The ceiba, according to this author, is higher than all other trees yet known."

Clavigero mentions a Mexican tree, the wood of which is very valuable, but poisonous, and if incautiously handled, when fresh cut, produces a swelling in the scrotum. Our author has forgot the name given to it by the Mexicans; nor has he ever seen the tree itself, nor been witness to the effect.

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Medicinal
and aroma-
tic gums.

This country abounds also with aromatic and medicinal trees, producing gums, resins, &c. From one of these a balsam is produced not in the least inferior to the celebrated balsam of Mecca. It is of a reddish black or yellowish white, of a sharp bitter taste, and of a strong but most grateful odour. It is common in the provinces of Panuco and Chiapan, and other warm countries. The kings of Mexico caused it to be transplanted into their celebrated garden of Huaxtepec, where it flourished, and was afterwards multiplied in all the neighbouring mountains. The Indians, in order to procure a greater quantity of this balsam, burn the branches, which affords more than mere distillation, though undoubtedly of an inferior quality; nor do they regard the loss of the trees, which are very abundant. The ancient Mexicans were wont to extract it also by decoction. The first parcel of this balsam brought from Mexico to Rome was sold at one hundred ducats per ounce; and was, by the apostolic see, declared to be matter fit for chrism; though different from that of Mecca, as Acofta and all other writers on this subject observe. An oil is likewise drawn from the fruit of this tree, similar in taste and smell to that of the bitter almond, but more acrimonious. From two other trees named the *huatonex* and *maripenda*, an oil was extracted equivalent to the balsam. The former is a tree of a moderate height; the wood of which is aromatic, and so hard, that it will keep fresh for several years, though buried under the earth. The leaves are small and yellow; the flowers likewise small and white, and the fruit similar to that of the laurel. The oil was distilled from the bark of the tree, after breaking it, and keeping it three days in spring-water, and then drying it in the sun. The leaves likewise afforded an agreeable oil by distillation. The *Maripenda* is a shrub with lanceolated leaves, the fruit of a red colour when ripe, and resembling the grape. The oil is extracted by boiling the branches with a mixture of some of the fruit.

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The tree producing liquid amber, the liquid storax of the Mexicans, is of a large size, the leaves similar to those of the maple, indented, white in one part and dark in the other, disposed of in threes; the fruit is thorny and round, but polygonous, with the surface and the angles yellow; the bark of the tree partly green and partly tawny. By incisions in the trunk they extract that valuable substance named *liquid amber*, and the oil of the same name, which is still more valuable. Liquid amber is likewise obtained from a decoction of the branches, but it is inferior to that obtained from the trunk.

The name *copalli* in Mexico is generic, and common to all the resins; but especially signifies those made use of for incense. There are ten species of these trees yielding resins of this kind; the principal of which is that from which the *COPAL* is got, so well known in medicine and varnishes. A great quantity of this was made use of by the ancient Mexicans, and is still used for similar purposes by the Spaniards. The *tecopalli* or *tepecopalli* is a resin similar to the incense of Arabia; which distils from a tree of moderate size that grows in the mountains, having a fruit like an acorn, and containing the nut enveloped in a mucilage, within which there is a small kernel useful in medicine.

The *mizquill*, or mezquite, is a species of true acacia, and the gum distilling from it is said to be the true gum arabic. It is a thorny shrub, with branches irregularly disposed, the leaves small, thin, and pinnated; the flowers being like those of the birch-tree.—The fruits are sweet and eatable, containing a seed, of which the barbarous Chichemecas were wont to make a kind of paste that served them for bread. The wood is exceedingly hard and heavy, and the trees are as common in Mexico as oaks are in Europe, particularly on hills in the temperate countries.

Of the elastic gum, which is found in plenty in Mexico, the natives were in use to make foot-balls, which, though heavy, have a better spring than those filled with air. At present they varnish with it their hats, cloaks, boots, and great coats, in a manner similar to what is done in Europe with wax; and by which means they are rendered all water-proof.

Our author laments that the natural history of vegetables in Mexico is very little known, and that of animals no better. The first Spaniards (says he) who gave them names, were more skilful in the art of war than in the study of nature. Instead of retaining the terms which would have been most proper, they denominated many animals tygers, wolves, bears, dogs, squirrels, &c. although they were very different in kind, merely from some resemblance in the colour of their skin, their figure, or some similarity in habits and disposition. The quadrupeds found in Mexico at the arrival of the Spaniards, were lions, tygers, wild cats, bears, wolves, foxes, the common stags, white stags, bucks, wild goats, badgers, pole-cats, weasles, martins, squirrels, polatucas, rabbits, hares, otters, and rats. All these animals are supposed by our author to be common to both continents. The white stag, whether it be the same species of the other or not, is undoubtedly common to both, and was known to the Greeks and Romans. The Mexicans call it the *king of the stags*. M. Buffon imagines the white

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animals.

Mexico. white colour of this creature to be the effect of captivity; but Clavigero says, that it is found wild, and of the same white colour, on the mountains of New Spain. In many other points, he also controverts the opinions of this celebrated naturalist, who will not allow the lion, tyger, or rabbit, to be natives of America. "The *miztli* of the Mexicans (says he) is no other than the lion without hair mentioned by Pliny, and totally distinct from the African lion; and the *ocelotl* is no way different from the African tyger, according to the testimony of Hernandez, who knew both the one and the other. The *tochtli* of Mexico is exactly the rabbit of the old continent; and at least as ancient as the Mexican calendar, in which the figure of the rabbit was the first symbolical character of their years. The wild cats, in size much larger than the domestic cats, are fierce and dangerous; the bears are all black, and more corpulent than those which are brought from the Alps into Italy. The hares are distinguished from those of Europe by their longer ears, and the wolves by a grosser head. According to M. Buffon, the Mexicans give the name of *polutaca* to the quimicpaltan, or flying rat of the Mexicans. We call it rat, because it resembles a rat in the head, though it is much larger, and flying; because in its natural state, the skin of its sides is loose and wrinkled, which it distends and expands together with its feet like wings, when it makes any considerable leap from one tree to another. This is confounded with the common squirrel on account of their likeness, but they are undoubtedly different. Mice were brought to Mexico in European ships; the rats were not so, but known in the country by the name of *quimichin*, a word metaphorically applied to spies."

Our author now proceeds to enumerate the quadrupeds common to New Spain with the rest of the continent of America. Among these he will not allow a place to the Peruvian sheep, the *buanaco*, and sloth; all of which are peculiar to South America. Hernandez indeed makes mention of the Peruvian sheep, and gives a drawing of it; but this was only on account of a few individuals brought thence from Peru, which the Mexicans called by that name, in the same manner as he describes several animals of the Philippine isles; not that they had ever been bred in Mexico, or found in any country of North America, unless it was some individual carried there, as they are carried as a curiosity from Europe. The animals which he allows to be common to both countries are, the Mexican hog, the moufete, the opossum, the armadillo, the *techichi*, a small animal resembling a dog; which being perfectly dumb, gave occasion to a report that the Mexican dogs could not bark. The flesh of this animal was eat by them, and was esteemed agreeable and nourishing food. After the conquest of Mexico, the Spaniards having neither large cattle nor sheep, provided their markets with this quadruped; by which means, the species soon came to be extinct, though it had been very numerous. The land-squirrel is very numerous in the kingdom of Michuacan, has great elegance of form, and is extremely graceful in its movement; but it cannot be tamed, and bites most furiously every person who approaches it.

Besides these, there are sea-lions, rattoons, and that

voracious animal named the *tapir*. Oviedo informs us, that he has seen it at one bite tear off two or three hand-breadths of skin from a hound, and at another a whole leg and thigh. The flesh is eatable, and its skin is valued on account of its being sufficiently strong to resist musket-balls. There are likewise great numbers of monkeys of many different kinds; some of which have heads resembling those of dogs. Some of them are strong and fierce, equalling a man in stature when they stand upright.

Among the animals peculiar to Mexico, is one named by our author *coyoto*, which appears to have been inaccurately described by other natural historians; some making it one species and some another. He says it has the voracity of a wolf, the cunning of a fox, the form of a dog, and in some properties resembles the *adive* and *chacal*. It is about the size of a mastiff, but more slender. The eyes are yellow and sparkling, ears small, pointed, and erect; the snout blackish, strong limbs, and the feet armed with large crooked nails. The tail is thick and hairy, the skin a mixture of black, brown, and white; and the voice is compounded of the howl of the wolf and the bark of the dog. It is one of the most common quadrupeds in Mexico, and most destructive to the flocks. When it invades a sheep-fold, if it cannot find a lamb to carry off, it seizes a sheep by the neck with its teeth, and coupling with it, and beating it on the rump with its tail, conducts it whether it pleases. It pursues the deer, and will sometimes even attack men. Its usual pace is a trot, but so quick that a horse at the gallop can scarce overtake it. The *tlalcojotl* or *tlalcoyoto* is about the size of a middling dog, and in our author's opinion is the largest animal that lives under the earth. Its head has some resemblance to that of a cat; but in colour and length of hair it resembles the lion.—It has a long thick tail, and feeds upon poultry and small animals, which it catches in the night-time. The *tepeizuintli*, or mountain-dog, though it is but of the size of a small dog, is so bold that it attacks deer, and sometimes kills them. Its hair and tail are long, the body black, but the head, neck, and breast, white. Mr Buffon reckons this animal the same with the glutton, but Clavigero denies it. Another animal, larger than the two foregoing, is called the *xoloitzcuintli*. Some of these are no less than four feet in length. It has a face like the dog, but tusks like the wolf, with erect ears, the neck gross, and the tail long.—It is entirely destitute of hair, excepting only the snout, where there are some thick crooked bristles. The whole body is covered with a smooth, soft, ash-coloured skin, spotted partly with black and tawney. This species of animals, as well as the two former, are almost totally extinct. A Lyncean academician named *Giovanni Fabri*, has endeavoured to prove that the *xoloitzcuintli* is the same with the wolf of Mexico; but this is denied by our author.

An animal called *ocotochtli*, a kind of wild cat, is remarkable more for the fabulous account of it than for any singular property with which it is really endowed. According to Dr Hernandez, when this creature takes any prey, it covers it with leaves, and afterwards mounting on some neighbouring tree, it begins howling to invite other animals to eat its prey; being itself always the last to eat; because the poison

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Description
of some
animals pe-
culiar to
Mexico.

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Curious
kind of
mole.

of its tongue is so strong, that if it eat first, the prey would be infected, and other animals which eat of it would die.

A curious animal of the mole kind is called *tozan* or *tuza*. It is about the size of an European mole, but very different otherwise. The body is about seven or eight inches long, and well made; the snout like that of a mouse, the ears small and round, with the tail short. The mouth is armed with very strong teeth, and its paws are furnished with strong crooked nails, with which it digs its habitation in the earth. It is extremely destructive to the corn fields by the quantity of grain it steals, and to the highways by the number of holes it makes in them; for when, on account of the dimness of its sight, it cannot find its first hole, it makes another, and so on. It digs the earth with its claws and two canine teeth which it has in the upper jaw. In digging, it puts the earth into two membranes like purses, which are under its ear, and which are furnished with muscles necessary for contraction and distension. When the membranes are full, it empties them by striking the bottom with its paws, and then digs again as before. These creatures are very numerous; but our author does not remember to have seen them in the place where land-squirrels inhabit.

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birds.

The birds are so numerous, and of such various appearances and qualities, that Mexico has been called the country of birds as Africa is of quadrupeds. Though Hernandez passes over a great number of species, he yet describes above 200 peculiar to the country. He allows to the eagles and hawks of Mexico a superiority over those of Europe; and the falcons of this country were formerly esteemed so excellent, that, by the desire of Philip II. an hundred of them were sent every year over to Spain. The largest, the most beautiful, and the most valuable kind of eagles, is called by the Mexicans *itzquaubtli*, and will pursue not only the larger kind of birds, but quadrupeds, and even men.

The ravens of Mexico do not, like those of other countries, feed upon carrion, but subsist entirely by stealing corn. The carrion is devoured by the birds called in South America *gallinazzi*, in Mexico *zopilots* and *aure*. By Hernandez they are said to be a species of ravens; but, according to Clavigero, they are very different, not only in their size, but in the shape of their head, their flight, and their voice.—They fly so high, that though pretty large, they are lost to the sight: before a hail-storm they may be seen wheeling in great numbers in the air, until they entirely disappear. They discover carrion by the acuteness of their sight and smell at a great height in the air, and descend upon it in a spiral flight. They are extremely numerous, and are very useful to the country, because they not only clear the fields of carrion, but attend the crocodiles, and destroy the eggs of these terrible animals. There is another bird, called by the Mexicans the *king of the zopilots*, on account, as it is said, that the true zopilot will not touch a bit of carrion till the other has first tasted it.

The aquatic birds are very numerous, and of great variety.—There are at least 20 species of ducks, a vast number of geese, with several kinds of herons, great numbers of swans, quails, water-rails, divers,

king's fishers, pelicans, &c. The multitude of ducks is sometimes so great, that they cover the fields, and appear at a distance like flocks of sheep. Some of the herons and egrets are perfectly white, some ash-coloured; others have the plumage of the body white, while the neck, with the tops and upper part of the wings, and part of the tail, are enlivened with a bright scarlet, or beautiful blue. Clavigero mentions a singular quality of the pelican, in which it differs from all other birds hitherto known, viz. that it assists such of its own species as are hurt or sick. Of this disposition the Americans sometimes take the advantage to procure fish without any trouble. They take a live pelican and break its wing, and, after tying it to a tree, conceal themselves in the neighbourhood: there they watch the coming of the other pelicans with their provisions; and as soon as they see them throw up the fish from the pouch they have below their bill, they run in, and leaving a little for the captive bird carry off all the rest. The *yoal-quachilli* is a small aquatic bird, with a long narrow neck, small head, long yellow bill, long legs, feet, and claws, and a short tail. It is remarkable for the weapons with which it is naturally provided. On the head is a little circle or coronet, of a horny substance, which is divided into three very sharp points, and there are two others on the fore-part of the wings.

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Singular
property of
the pelican.

Numbers of the other classes of birds are valuable for their flesh, plumage, or song, while some are remarkable for their extraordinary instinct or other properties. Our author enumerates more than 70 species of those which afford an agreeable and wholesome food. Besides the common fowls which were brought from the Canaries to the Antilles, and from these to Mexico, there were, and still are, fowls peculiar to the country itself. These partly resemble the common fowl and partly the peacock, whence they had the name of *gallipavos* from the Spaniards. From Mexico they were imported into Europe, where they have multiplied very fast, especially in Italy, though the common fowls have multiplied much more in Mexico. There are three kinds of pheasants; one of which is as large as a goose, and very docile. It will become so tame as to pick food from its master's hand, and run to meet him with signs of joy when he comes home, shut the door with its bill, &c. By keeping in a yard along with other poultry, it learns to fight like a cock, raising the feathers of its crest, as cocks do those of their neck.

There are great numbers of birds valuable on account of their plumage, which was made use of by the Mexicans in their excellent mosaic works; an art which seems now to be totally lost. Peacocks have been carried from the old continent to Mexico; but, not being attended to, have propagated very slowly. The birds remarkable for their song are likewise very numerous; among which that called the *centzonitl*, by Europeans the *mocking-bird*, is the most remarkable, on account of its counterfeiting naturally the notes of all others it hears. It has been attempted to bring it to Europe, but without success. The cardinals are very remarkable, not only on account of their fine colours, but likewise of their notes; and even the sparrows have a most delightful and various song.

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There are great numbers of beautiful parrots; and there is a bird which counterfeits the human voice, but in a kind of burlesque tone, and will follow travellers a great way. The *tzacua* is remarkable for its instinct. Birds of this kind live in society, every tree being a village or city to them, having great numbers of nests in the neighbourhood of each other, all hanging from the boughs. One of them, whose office it is to be the head or guard of the village, resides in the middle of the tree; from which it flies about from one nest to another, visiting them all, and after singing a little, returns to its place, while the rest continue perfectly silent. If any bird of a different species approaches the tree, he flies to it, and with his bill and wings endeavours to drive it off; but if a man or any large animal comes near, he flies screaming to another tree; and if at that time any of his fellows happen to be returning to their nests, he meets them, and, changing his note, obliges them to retire again: as soon as he perceives the danger over, he returns to his wonted round of visiting the nests.

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Reptiles.

Mexico, like all other American countries, abounds with reptiles, many of them of an enormous size. The crocodiles are not less to be dreaded than those of Africa or Asia; and there are likewise some of those monstrous serpents met with in the East Indies and in South America; though happily the species of those terrible creatures seems to be nearly extinct, as they are seldom to be found but in some solitary wood, or other remote place. There are great numbers of lizards, some of which the people suppose to be poisonous; but our author thinks this opinion ill founded. There are several kinds of poisonous serpents, of which the rattle-snake is one. The *ceno-coatl* is another poisonous serpent, and remarkable for having a luminous appearance in the dark; by which, as by the rattle in the tail of the former, travellers are warned to avoid it. Among the harmless snakes is a very beautiful one about a foot in length, and of the thickness of the little finger. It appears to take great pleasure in the society of ants, inasmuch that it will accompany these insects upon their expeditions, and return with them to their usual nest.—It is called both by the Mexicans and Spaniards the *mother of the ants*; but our author supposes that all the attachment which the snake shows to the ant-hills proceeds from its living on the ants themselves. The ancient Mexicans were wont to take delight in keeping an harmless green snake which they caught in the fields, and which, when well fed, would grow to the length of five or six feet. It was generally kept in a tub, which it never left but to receive food from the hand of its master; and this it would take either mounted on his shoulder or coiled about his legs.

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Aquatic
animals.

The aquatic animals are innumerable. Clavigero mentions a species of frogs so large that a single one will weigh a pound, and which are excellent food.—Of fish proper for food, our author says that he has counted upwards of 100 species, without taking in the turtle, crab, lobster, or any other crustaceous animal. The sharks are well known for their voracity. A whole sheep's skin, and even a large butcher's knife, has been found in the belly of one of them. They

are accustomed to follow vessels, to devour any filth that is thrown overboard; and, according to Oviedo, they have been known to keep up with ships sailing before a fair wind for no less than 500 miles. The bottetto is a fish about eight inches in length, but excessively thick. While this fish lies alive upon the beach, it swells whenever it is touched to an enormous size, and boys often take pleasure in making it burst with a kick. The liver is so poisonous as to kill with strong convulsions in half an hour after it is eaten. The oechione is a round flat fish, of eight or ten inches in diameter; the under part of the body being perfectly flat, but the upper part convex; and in the centre, which is the highest part, it has a single eye as large as that of an ox, furnished with eye-lids like the eyes of land animals. This eye remains open even after the fish is dead, and has an hideous appearance, so as sometimes to strike the spectators with horror. Campoi endeavours to prove, that this is the fish named by Pliny *uranoscopus*. The Roman historian does not describe this fish; but Clavigero observes, that the name of *uranoscopus* might be equally applicable to all fish which have eyes upon the head that look up to the sky, as skates and other flat fish. The axolotl is a great ugly water-lizard, remarkable for having a periodical evacuation of blood from the uterus, like the human species. It is eatable, tastes like an eel, and the flesh is looked upon to be good in consumptions. There are likewise a vast variety of shells, sponges, and lithophyts. Hernandez gives the figure of a sponge sent to him from the Pacific Ocean, which was of the shape of a man's hand, but with ten or more fingers; of a clay colour, with black backs and red streaks, harder than the common sponges.

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Of flying and other minute insects, the number is prodigiously great. There are a variety of beetles: some of a green colour make a great noise in flying; on which account children are fond of them. There are great numbers of shining beetles, which make a delightful appearance at night, as well as the luminous flies which abound in the country. There are six kinds of bees and four kinds of wasps; of which last, one collects wax and honey of a very sweet taste: another is called the *wandering wasp* from its frequent change of abode; and in consequence of these changes, it is constantly employed in collecting materials for its habitations. There is also a black hornet with a red tail, the sting of which is so large and strong, that it will not only penetrate a sugarcane but even the trunk of a tree. The lake of Mexico abounds with a kind of fly, the eggs of which are deposited upon the flags and rushes in such quantities as to form large masses. These are collected by the fishermen, and carried to market for sale. They are eaten by both Mexicans and Spaniards, and have much the same taste as the caviare of fish. The Mexicans eat also the flies themselves ground and made up with salt-petre. There are abundance of gnats in the moist places and lakes; but the capital, though situated upon a lake, is entirely free from them. There are other flies which make no noise in their flight, but cause a violent itching by their bite; and if the part be scratched, an open wound is apt to ensue. The butterflies are in vast numbers, and

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Insects.

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their wings glow with colours far superior to those of Europe; the figures of some of them are given by Hernandez. But notwithstanding its beauties and advantages, Mexico is subject to the dreadful devastations of locusts, which sometimes occasion the most destructive famines.

There are some of the worms of Mexico made use of by the inhabitants as food; others are poisonous. There are great numbers of scolopendræ and scorpions, some of the former growing to an immense size. Hernandez says, that he has seen some of them two feet long and two inches thick. The scorpions are very numerous; and in the hot parts of the country their poison is so strong as to kill children, and give terrible pain to adults. Their sting is most dangerous during those hours of the day in which the sun is hottest. In the province of Michuacan is a singular species of ant, larger than the common one, with a greyish body and black head. On its hinder part is a little bag full of a sweet substance, of which children are very fond. The Mexicans suppose this to be a kind of honey collected by the insect; but Clavigero thinks it rather is its eggs. There is a mischievous kind of tick, which in the hot countries abounds among the grass. From thence it easily gets upon the cloaths, and from them upon the skin. There it fixes with such force, from the particular figure of its feet, that it can scarcely be got off. At first it seems nothing but a small black speck, but in a short time enlarges to such a degree, from the blood which it sucks, that it equals the size of a bean, and then assumes a leaden colour. Oviedo says, that the best and safest method of getting speedily rid of it is by anointing the part with oil, and then scraping it with a knife.— If it is not speedily removed, a wound is made similar to that which the nigera or chegoe makes. The following insects were eaten by the ancient Mexicans: 1. The *atelepitz*, a marsh beetle, resembling in shape and size the flying beetles, having four feet, and covered with an hard shell. 2. The *atopingn*, a marsh-grasshopper of a dark colour, and great size, being not less than six inches long and two broad. 3. The *abuibuitla*, a worm which inhabits the Mexican lake, four inches long, and of the thickness of a goose-quill, of a tawney colour on the upper part of the body, and white upon the under part. It stings with its tail, which is hard and poisonous. 4. The *ocuiliztac*, a black marsh-worm, which becomes white on being roasted.

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Curious
zoophytes.

Among the curious productions of the animal kind to be met with in this country, Clavigero mentions a kind of zoophytes which he saw in the year 1751, in a house in the country, about ten miles from Angelopoli, towards the south-east. They were three or four inches long, and had four very slender feet, with two antennæ; but their body was nothing more than the fibres of the leaves, of the same shape, size, and colour with those of the other leaves of the trees upon which these creatures were found. Gemelli describes another kind of these zoophytes which are found in Manilla.

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Silk and
cochineal.

Mexico produces also silk-worms: and the manufacture of silk might be carried on to great advantage, were it not prohibited for some political reasons. Besides the common silk, there is another found in the woods, very white, soft, and strong. It grows on the

trees in several maritime places, particularly in dry seasons. Unless by poor people, however, this silk is not turned to any use, partly from inattention to their interests, but “chiefly (says our author) to the obstructions which would be thrown in the way of any one who should attempt a trade of that kind. We know from Cortes’s letters to Charles V. that silk used to be sold in the Mexican markets; and some pictures are still preserved, done by the ancient Mexicans upon a paper made of silk.”

Cochineal is one of the most valuable products of Mexico, and great care is taken to rear the insect in different parts; but the best is that which comes from the province of Mizteca. Some have reckoned that more than 2500 bags of cochineal are sent every year from Mizteca to Spain; and the trade in that article carried on by the city of Oaxaca is computed at 200,000 crowns value.

Though Mexico, as we have seen, was originally inhabited by a number of different nations, yet all of them resembled each other pretty much, not only in character, but in external appearance. “They generally rather exceed (says our author) than fall under the middle size, and are well proportioned in all their limbs. They have good complexions, narrow foreheads, black eyes, clean, firm, white, and regular teeth; thick, black, coarse, glossy hair; thin beards, and generally no hair upon their legs, thighs, and arms, their skin being of an olive colour. There is scarcely a nation on earth in which there are fewer persons deformed; and it would be more difficult to find a single hump-backed, lame, or squint-eyed man among a thousand Mexicans, than among an hundred of any other nation. The unpleasantness of their colour, the smallness of their foreheads, the thinness of their beards, and the coarseness of their hair, are so far compensated by the regularity and fine proportion of their limbs, that they can neither be called very beautiful nor the contrary, but seem to hold a middle place between the extremes. Their appearance neither engages nor disgusts; but among the young women of Mexico, there are many very beautiful and fair, whose beauty is at the same time rendered more winning by the natural sweetness of their manner of speaking, and by the pleasantness and natural modesty of their whole behaviour. Their senses are very acute, especially that of sight, which they enjoy unimpaired to the latest age. Their constitutions are sound, and their health robust. They are entirely free of many disorders which are common among the Spaniards; but of the epidemical diseases to which their country is occasionally subject, they are generally the victims: with them these diseases begin, and with them they end. One never perceives in a Mexican that stinking breath which is occasioned in other people by the corruption of the humours or indigestion. Their constitutions are phlegmatic; but the pituitous evacuations from their heads are very scanty, and they seldom spit. They become grey-headed and bald earlier than the Spaniards; and although most of them die of acute diseases, it is not very uncommon among them to attain the age of an hundred. They are now, and ever have been, moderate in eating, but their passion for strong liquors is carried to the greatest excess. Formerly they were kept within bounds by the severity of the laws; but now

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description
of the inha-
bitants.

Mexico. now that these liquors are become so common, and drunkenness is unpunished, one half of the people seem to have lost their senses; and this, together with the poor manner in which they live, exposed to all the baneful impressions of disease, and destitute of the means of correcting them, is undoubtedly the principal cause of the havoc which is made among them by epidemical disorders.

"Many persons allow the Mexicans to possess a great talent of imitation, but deny them that of invention; a vulgar error, which is contradicted by the ancient history of that people. Their minds are affected by the same variety of passions with those of other nations, but not to an equal degree. The Mexicans seldom exhibit these transports of anger, or frenzies of love, which are so common in other countries. They are slow in their motions; and show a wonderful tenacity and steadiness in those works which require time and long continued attention. They are most patient of injury and hardship; and where they suspect no evil intention, are most grateful for any kindness shown: but some Spaniards, who cannot distinguish patience from insensibility, nor distrust from ingratitude, say proverbially, that the Indians are alike insensible to injuries or benefits. That habitual distrust which they entertain of all who are not of their nation, prompts them often to lie and betray; so that good faith certainly has not been respected among them so much as it deserves. They are by nature taciturn, serious, and austere; and show more anxiety to punish crimes than to reward virtues.

"Generosity and perfect disinterestedness are the principal features of their character. Gold with the Mexicans has not that value which it enjoys elsewhere. They seem to give without reluctance what has cost them the utmost labour to acquire. The neglect of selfish interests, with the dislike which they bear to their rulers, and consequently their aversion to perform the tasks imposed by them, seem to have been the only grounds of that much exaggerated indolence with which the Americans have been charged; and, after all, there is no set of people in that country who labour more, or whose labour is more necessary. The respect paid by the young people to the old, and by children to their parents, seem to be feelings that are born with them. Parents are very fond of their children; but the affection which husbands bear to their wives is certainly less than that which wives bear to their husbands; and it is very common for the men to love their neighbours wives better than their own.

Courage and cowardice seem alternately so to affect their minds, that it is often difficult to determine whether the one or the other predominates. They meet dangers with intrepidity, when they proceed from natural causes, but are easily terrified by the stern look of a Spaniard. That stupid indifference about death and eternity, which many authors have thought inherent in the character of every American, is peculiar only to those who are yet so rude and uninformed as to have no idea of a future state."

Thus much with respect to the general character of the Mexicans: but our author observes, that "the modern Mexicans are not in all respects similar to the ancient, as the Greeks of these days have little resemblance to those who lived in the times of Plato and

Pericles. The ancient Mexicans showed more fire, and were more sensible to the impressions of honour. They were more intrepid, more nimble, more active, more industrious; but they were at the same time more superstitious and cruel."

The Toltecas, who first inhabited Mexico, were accounted much more polished than those who came after them, insomuch that in after ages it was customary to distinguish people of ingenuity and learning by the name of Toltecas. They always lived in society, collected into cities, under the government of kings, and had regular laws. They were more addicted to the arts of peace than of war; and it was to them that the succeeding nations owed themselves indebted for their knowledge of the culture of grain, cotton, pepper, &c. They understood the art of casting gold and silver, and melting them in whatever forms they pleased, acquiring also great reputation from their skill in cutting gems of all kinds; and they were besides well versed in the sciences of astronomy and chronology.

According to the ancient histories of these people, they observed, about an hundred years before the Christian era, how far the solar year exceeded the civil one; supplying the defect, as we do, by the addition of a day once in four years. In the year 660, while their monarchy continued in Tula, a celebrated astronomer, named Huematzin, assembled with the king's consent all the wise men of the nation; and, with their assistance, painted a famous book named *Teomoxli*, or "divine book," in which were represented, in very plain figures, the origin of the Indians, their dispersion after the confusion of tongues of Babel, their journey in Asia, their first settlements in America, the founding of the kingdom of Tula, and their progress till that time: but these, and other accounts of their great knowledge and accuracy, favour too much of exaggeration, or perhaps invention, from both which it is impossible to clear the Spaniards when speaking of American affairs.

The Chichimecas derived their knowledge of agriculture from the Toltecas, and of consequence the Mexicans also. Being destitute of ploughs or animals of sufficient strength to assist them in their labour, they made use of an instrument of hard copper, which they called *coatil* or *coa*, but differing in shape either from a spade or mattock. They used copper axes to cut trees, the figure of which was the same with ours; only that they put the ax into the eye of the handle, instead of putting the handle into the eye of the ax as we do. They had several other instruments of agriculture, but the forms of them are not mentioned by historians. They watered their fields by means of the rivers and small torrents which came from the mountains; raising dams to collect them, and forming canals to conduct them properly to the places which required moisture. They used inclosures of stone, as well as hedges for the fields, using for their hedges the aloe plant, which is well calculated for the purpose; and what reparations were necessary they gave in December. They dibbled their maize: a method of sowing more slow indeed than the ordinary one, but which certainly repays the trouble by a vastly larger crop, as well as by saving a very considerable quantity of seed. Close to the newly-sown fields they commonly

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Of the Toltecas and Chichimecas.

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Their progress in agriculture.

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monly erected a small tower of wood, where a man kept watch, in order to drive away the birds that came to feed upon the grain; a custom still preserved among the Spaniards.

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Magnificent gardens.

In the cultivation of their gardens, the Mexicans were extremely skilful and magnificent; planting in them not only kitchen herbs, but fruit-trees, medicinal herbs, and flowers, with great taste and regularity. Some of the royal gardens excited the admiration of the Spaniards so much, that Cortes, in a letter to Charles V. informed him that the garden at Huaxtepec was the most extensive, the most beautiful, and most delightful, that had ever been beheld. It was six miles in circumference, and watered by a beautiful river which crossed it; and there were pleasure-houses erected at proper distances from one another. It was for many years preserved by the Spaniards.—The plants most cultivated, next to maize, were cotton, cacao, and aloe; which last served a great many useful purposes. See ALOE.

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Tame animals.

Though they had not the advantage of the larger quadrupeds, as horses, oxen, or sheep, they bred up an immense number of quadrupeds unknown in Europe. Private persons brought up the small quadrupeds already mentioned, resembling little dogs; as well as turkeys, quails, geese, ducks, and other kinds of fowl. In the houses of the great men were bred fish, deer, rabbits, and a variety of birds; and in the royal palaces, almost all the species of quadrupeds and winged animals to be found in these kingdoms were kept, as well as a great number of aquatic animals and reptiles. According to Clavigero, Montezuma II. surpassed all the kings in the world in this kind of magnificence; and there never was a nation equal to the Mexicans in the care they took in taming animals.

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Paintings.

Painting was an art in great request among the Mexicans, and one of very great use; as it was only by means of paintings that they recorded their histories. This art they derived, like others, from the Toltecas. Some of these paintings were mere images of their gods, kings, heroes, or of terrestrial objects. Others were historical, containing an account of particular events; others mythological, of which a volume is preserved in the great library of the order of Bologna: others were codes of laws, civil and religious; while some were chronological, astronomical, or astrological; in which was represented their calendar, the position of the stars, changes of the moon, eclipses, and prognostications and variations of the weather. Great numbers of these were burned by the superstitious Spaniards, who imagined that they contained some emblems of heathen worship. They had likewise geographical paintings, which served not only to show the extent and boundaries of their possessions, but likewise the situation of places, the direction of the coasts, and the course of the rivers. In his first letter to Cha. V. Cortes says, that having made inquiries if there was any secure harbour for vessels on the Mexican coast, Montezuma presented him with a painting of the whole coast, from the port of Vera Cruz, at that time called *Chalchiuhuecan*, to the river Coatzacoalco. Another author informs us also, that Cortes, in a long and difficult voyage which he made to the bay of Honduras, made use of a chart presented to him by the

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lords of Coatzacoalco, in which all the places and rivers were marked from the coast of Coatzacoalco to Huejacallan.

As every thing relating to the Mexican empire was thus delineated in painting, the artists were innumerable: and had the numerous paintings been preserved, we might by means of them have had a complete history of Mexico; but vast numbers were destroyed by the superstitious zeal of the Spaniards. The chief school of painting was in Tezcuco: and of the paintings made there they collected such a mass, that it resembled a little mountain; and to all these they set fire at once, to the inexpressible grief of the Indians, and even of themselves, when they came to know their error: for they were compelled afterwards to attempt to remedy the evil, by collecting all the paintings that could be found throughout the empire, and to obtain what information they could from the mouths of the Indians. But though they recovered many, these were still not sufficient; for, from that time forward, the possessors of paintings became so jealous, that they concealed them from the Spaniards with the utmost care; and it was in a manner impossible to make them part with a single piece.

The cloth on which these paintings were done was made of the thread of the aloe or a kind of palm; or they painted on sheeps skins or upon paper. This last was made of the leaves of a certain kind of aloe, steeped like hemp, and afterwards washed, stretched, and smoothed. They used also the bark of other trees, prepared with gum; but we are ignorant of the method they used in the manufacture. This paper is similar in thickness to the European pasteboard, but softer, smoother, and more easy for writing. In general it was made up in very long sheets, which they preserved in rolls, or folded like bed-screens. The volume of Mexican paintings, preserved in the library of Bologna, is a thick skin, ill-dressed, composed of different pieces painted all over, and folded up in that manner. The beautiful colours which they employed both in their paintings and in their dyes, were obtained from wood, leaves, and the flowers of different plants, as well as from various animal substances. Their white was made from a kind of stone which burns into a fine plaster; or from a mineral, which after being made into a paste worked like clay, and formed into small balls, turns white in the fire like Spanish white. Their black was got from another mineral, which has a disagreeable smell, or from the foot of a kind of pine collected in small earthen vessels. They obtained blue and azure colours from indigo; but their mode of obtaining these was very different from that used by the moderns. They put the branches of the plant into hot, or rather lukewarm, water: and after having stirred them about for a sufficient time with a stick or laddle, they passed the water, when impregnated with the dye, into certain pots or cups in which they let it remain until the solid part of the dye was deposited; after which they poured off the water. This sediment was first dried in the sun, and afterwards put between two plates before a fire until it grew hard. They had another plant which likewise afforded a blue colour, but inferior to the indigo. Red was obtained from the seeds of the achiote or

rocou,

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rocou, and purple from cochineal. Their yellows were ochre, and a colour extracted from the beautiful flower of a plant resembling artemisia. With nitre these flowers afforded a fine orange colour; and by means of alum they extracted other colours.

The Mexican painters were by no means arrived at much perfection in the knowledge of light and shade, or of design; nevertheless, in some of the ancient paintings, particularly in the portraits of the kings, the proportions were exactly observed. But this was by no means the case in their common paintings: though this is ascribed by Clavigero, not to the want of skill in these painters, but to the haste with which the figures were executed, and of which the Spaniards were witnesses. Besides paintings, however, the Mexicans are said to have employed hieroglyphics and characters: but this is absolutely denied by our author; who tells us, that "they represented material things by their proper figures; but, in order to save labour, paper, and colours, they contented themselves with representing part of an object, which was sufficient to make it understood. But as we cannot understand the writings of others till we have learned to read them, in like manner those American authors, who say that the Mexicans made use of characters, required to have been first instructed in the Mexican manner of representing objects, in order to have been able to understand the paintings which served them in place of writing. When they would represent any person, they painted a man, or a human head, and over it a figure expressing the meaning of his name, as appears in the figures of the Mexican kings. To express a city or village, they painted in like manner a figure which signified the same thing, with its name. To form their histories or annals, they painted on the margin of the cloth or paper the figures of the years in so many squares, and at the side of each square the event or events which happened that year: and if, on account of the number of years, the history of which they meant to relate, they could not all be contained in one canvas, they were continued on another. With respect to the order of representing the years and events, it was at the liberty of the historian to begin at whichever angle of the piece he pleased; but at the same time constantly observing, that if the painting began at the upper angle of the right-hand, he proceeded towards the left; but if it began, as it most commonly did, at the upper angle of the left hand, he proceeded straight downwards. If he painted the first year at the lower angle of the left, he continued towards the right; but if he began at the lower angle of the right, he painted straight upwards: so that on the upper part of his canvas he never painted from left to right, nor ever on the lower part from right to left; never advanced upwards from the left, nor downwards from the right. When this method of the Mexicans is understood, it is easy to discover at first sight which is the beginning and which the ending of any historical painting. Their paintings, however, ought not to be considered as a regular full history, but only as monuments and aids of tradition. We cannot express too strongly the care which parents and masters took to instruct their children and pupils in the history of the nation. They made them learn speeches and discourses which they could not express

by the pencil; they put the events of their ancestors into verse, and taught them to sing them. This tradition dispelled the doubts and undid the ambiguity which paintings alone might have occasioned; and, by the assistance of those monuments, perpetuated the memory of their heroes and of virtuous examples; their mythology, rites, laws, and customs.

"Nor did that people only make use of tradition, paintings, and songs, to preserve the memory of events, but also of threads of different colours and differently knotted. This curious method of the representation of things, however much used in Peru, does not appear to have been employed in the province of Anahuac, if not in the most early ages; for no traces of such monuments are now to be found. Botarini says, that after the most diligent search, he with difficulty found one in a place in Tlascala, the threads of which were already wasted and consumed by time. If those who peopled South America ever passed the country of Anahuac, they possibly might have left there this art, which was afterwards abandoned for that of painting, introduced by the Toltecs or some other nation still more ancient."

The Mexicans arrived at greater perfection in sculpture, casting of metals, and mosaic works, than in painting. Sculpture was likewise one of the arts exercised by the ancient Toltecs; but the Mexicans had sculptors among them when they left their native country of Atztlan. Several of the Toltec statues, however, were preserved till the time of the conquest, particularly that of the idol Tlaloc, placed upon the mountain of the same name, and some gigantic statues in one of their temples. Stone and wood were the usual materials of their statues: the former was worked with a chisel made of flint; and, in spite of the unsuitableness of the instrument, such was the phlegmatic nature of the people, that they surmounted every difficulty arising from the tediousness of the work. In their statues they learned to express all the attitudes and postures of which the human body is capable. They observed the proportions exactly, and could when necessary execute the most delicate strokes with the chisel. They not only made entire statues, but cut out in wood and in stone figures in basso relievo; of which kind are those of Montezuma II. and one of his sons, recorded with praises by Acosta. They also made statues of clay and wood, employing for these a chisel of copper. The number of their statues was in proportion to that of their idols; but so active were the Spanish priests in destroying these, that there is now scarce any vestige of them remaining. The foundation of the first church in Mexico was laid with idols; on which occasion many thousand statues of their gods were necessarily broke in pieces. In casting of metals, however, the Mexicans greatly excelled their works either of painting or sculpture. "The miracles they produced of this kind (says Clavigero), would not be credible, if, besides the testimony of those who saw them, a great number of curiosities of this kind had not been sent from Mexico to Europe. The works of gold and silver sent in presents from the conqueror Cortes to Charles V. filled the goldsmiths of Europe with astonishment; who, as several authors of that period attest, declared that they were altogether inimitable. The Mexican founders made both of gold and silver

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Preserved the memory of events by knotted threads.

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Their knowledge in sculpture.

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Excelled in the art of casting metals.

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They did not use hieroglyphics or characters.

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Careful to preserve their traditions.

Mexico.

silver the most perfect images of natural bodies. They made a fish in this manner, which had its scales alternately one of silver and the other of gold; a parrot with a moveable head, tongue, and wings; and an ape with a moveable head and feet, having a spindle in its hand in the attitude of spinning. They set gems in gold and silver, and made most curious jewelry of great value. In short, these sort of works were so admirably finished, that even the Spanish soldiers, all stung with the same wretched thirst for gold, valued the workmanship above the materials. This wonderful art, formerly practised by the Toltecas, the invention of which they ascribed to one of their gods, has been entirely lost by the debasement of the Indians, and the indolent neglect of the Spaniards. We are doubtful if there are any remains of those curious works; at least we apprehend that it would be more easy to find them in some of the cabinets of Europe than in all New Spain. Covetousness to profit by the materials must unquestionably have conquered all desire to preserve them as curiosities." The works of the Mexicans in gold and silver, executed with the hammer, were much inferior to those of the Europeans.

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Beautiful
mosaic.

But of all the works executed by the ancient Mexicans, those of mosaic were the most curious, as well as most highly valued by themselves. These were made of the feathers of birds; and for procuring them they reared a great number of those birds of fine plumage, with which the country abounded, not only in the royal palaces, but also in private houses; and at certain seasons they carried off the feathers for these purposes, or to sell them at market. They valued particularly the feathers of the humming birds, on account of their smallness, fineness, and various colours; and in these, as well as other birds of fine plumage, nature supplied them not only with all the colours producible by art, but likewise with many which art cannot imitate. Their mosaic works, as well as indeed all others of the Mexicans, required infinite patience. At the undertaking of every work of this kind several artists assembled; and having agreed upon a design, and fixed their measures and proportions, each artist charged himself with the execution of a certain part of the image, and exerted himself so diligently in it, that he frequently spent a whole day in adjusting a feather; first trying one and then another, viewing it sometimes one way, then another, until he found one which gave his part that ideal perfection proposed to be attained. When the part which each artist undertook was done, they assembled again to form the entire image from them. If any part happened to be in the least deranged, it was wrought again until it was perfectly finished. They laid hold of the feathers with small pincers, that they might not do them the least injury, and pasted them on the cloth with some glutinous matter: then they united all the parts upon a little table or a plate of copper, and flattened them softly until they left the surface of the image so equal and smooth, that it appeared to be the work of a pencil. These works were prodigiously admired by the Spaniards. "It is wonderful (says Acosta) how it was possible with the feathers of birds to execute works so fine and so equal, that they appear the performance of the pencil; and what neither the pencil nor the colours in painting can effect, they have, when viewed

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from a side, an appearance so beautiful, so lively, and so animated, that they give delight to the sight. Some Indians, who are able artists, copy whatever is painted with a pencil so exactly with plumage, that they rival the best painters of Spain." The last artist in this admirable kind of work lived lately in Pazcuaro, the capital of Michuacan; but it is most probable that the art either has already died or will die with him. A beautiful kind of mosaic was likewise done with broken shells; and this is still carried on in Guatemala. There were many other artists who formed figures in imitation of the mosaic works, with flowers and leaves upon mats, which were made use of at festivals; and these were eagerly sought after by the Spanish nobility, on account of their singular beauty. Others imitated with silk the figures done with feathers; but these last were always greatly superior.

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Their architecture

The Mexicans were skilled in architecture even before they left their native country; and many edifices still remain which were constructed by them during their frequent journeys from one place to another. At their first arrival on the lake, they had no other materials to build their houses with but reeds and mud, until the success of their commerce allowed them to purchase better materials. When the city came to its perfection, the houses of the principal people were constructed of stone and lime: they consisted of two floors, having halls, large court-yards, and chambers fitly disposed: the roofs were flat and terraced; the walls so well whitened, polished, and shining, that they appeared to the Spaniards when at a distance to have been constructed of silver. The floor was paved with plaster, perfectly level, plain, and smooth. Many of their houses were crowned with battlements and turrets; and their gardens had fish-ponds, and the walks of them symmetrically laid out. The large houses had in general two entrances, the principal one to the street, the other to the canal: they had no wooden doors to their houses, but covered the entrance with small reeds, from whence they suspended a string of cocoa shells, or some other materials which would make a noise, so as to awake the attention of the family when any person lifted up the reeds to enter the house. —The houses of the poorer sort were constructed of reeds, unburnt bricks, stone, or mud; and the roofs made of a kind of long hay which grows plentifully in the fields, particularly in the warm parts of the country. For this purpose they used also the leaves of the aloe placed in the manner of tiles, to which they bear some resemblance both in thickness and shape. One of the columns or supports of these houses was generally a tree in the vigour of its growth; by which means, besides the pleasure derived from its foliage and shade, they saved themselves some labour and expence. These houses had one or more apartments according to the circumstances of the family.

Our author is of opinion, that the ancient Mexicans understood the method of constructing arches or vaults, as appears, he says, from some remains of their buildings as well as from their paintings. They had likewise cornices and other ornaments of architecture. They had also square or cylindrical columns; but it is not known whether these had any capitals or not. They frequently adorned them with figures in *basso*

relievo;

Mexico.

Mexico.

relievo; but their great ambition was to have them all made out of one stone. The foundations of the large houses in the capital were laid upon beams of cedar driven into the ground, on account of its want of solidity; and the same method is still practised by the Spaniards. The roofs of these were made of cedar, fir, cypress, pine, &c. In the royal palaces the columns were of marble or even of alabaster, which the Spaniards mistook for jasper. In the reign of Ahuizotl a new kind of stone, named *tetzontli*, was discovered in the Mexican lake, which was ever afterwards made use of for building. It is hard, light, and porous like a sponge; by which means the lime adheres very firmly to it. It is valued likewise on account of its colour, which is a blood red. Some of the pavements were chequered with marble and other valuable stones.

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Remark-
able aque-
ducts.

The most remarkable pieces of Mexican architecture, however, were their aqueducts. There were two which conveyed the water to the capital from the distance of two miles. These were constructed of stone and cement five feet high, and two paces broad, upon a road for that purpose upon the lake; by which the water was brought to the entrance of the city, from whence it was sent forth in smaller channels to supply the different fountains. The famous aqueduct of Chempoallan, which was done in the 16th century, is worthy of being ranked among the greatest in Europe. The conductor of this work was a Franciscan missionary named *Tembleque*; and it was executed with great skill by the Chempoallese. The water was brought from a great distance, and the country through which it must pass was mountainous and rocky; but every difficulty was overcome by the industry of the Mexicans. The aqueduct, including all the turnings and windings, exceeded 30 miles in length. The principal difficulty consisted in crossing three great precipices, over which they were obliged to construct three bridges, the first of 47, the second of 13, and the third of 67 arches. The largest arch was 100 feet high, and 61 broad; so that a large vessel could have passed under it. It must, however, be observed, that, in executing this undertaking, the Mexicans were undoubtedly assisted by European tools, and the directions of European workmen; so that we cannot with strict propriety call it one of their works.

Though the ancient Mexicans never used any instruments of iron in their works, they nevertheless executed beautiful engravings by means of tools made of flint stone. They wrought also marble, jasper, alabaster, *itztli*, and other valuable stones. Of *itztli* they made their looking-glasses, which were sometimes set in gold, the sharp pieces which were set in their swords, and razors to shave with. These last were made with such expedition, that an artist could finish upwards of an hundred in an hour.

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Excellent
Jewellers.

They were, as has already been observed, expert jewellers, and understood the art of cutting and polishing the stones, as well as of setting them. The gems most common in their country were the emeralds, amethysts, cornelians, turquoises, and others unknown in Europe. Emeralds were so common, that no lord or noble wanted them; and none of them died without having one fixed to his lip, that it might serve him, as they imagined, in the other world, in-

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stead of a heart. When Cortes returned the first time to Spain, he brought with him five emeralds valued, by the jewellers there, at 100,000 ducats. The first was in the form of a rose; the second of an horn; the third of a little fish with eyes of gold; the fourth in the form of a bell, with a fine pearl for a clapper. The fifth was a small cup with a foot of gold, and four little golden chains which united in a pearl in the form of a button. For this alone the Genoese merchants offered 40,000 ducats, in order to sell it again to the grand signior. Besides these, he had two emerald vases valued at 300,000 ducats; but these last were lost by shipwreck in the unfortunate expedition of Charles V. against Algiers. There are no such gems wrought at present, nor is it even known where the emerald mines are situated; though there are still extant some enormous masses of this precious stone, particularly two in as many churches; but the priests take care to secure them with iron chains, lest any body should carry them off.

In other more common manufactures the Mexicans were by no means deficient. The earthen ware of Cholula was much praised by the Spaniards; and they had the art of ornamenting this kind of ware with various colours, though they did not understand the making of glass. Their carpenters wrought with instruments of copper; and there are still remains of their labours which display a tolerable skill. Almost every one was acquainted with the method of making cloth. Being destitute of wool, common silk, lint, or hemp, they were obliged to supply the deficiency by other materials. For wool they substituted cotton, for silk they used feathers, the wool of the hare or rabbit; and instead of lint and hemp, they used the fibrous part of the leaves of the aloe. From these last they obtained a thread as fine as from lint; and from some species they had a coarser sort resembling hemp. To obtain this thread they soaked the leaves in water, cleaned them, exposed them to the sun, and then beat them till they were fit to be spun. Sometimes they interwove with their cotton the finest down on the belly of the rabbits or hares, after having spun it into thread; and of these they made most beautiful cloths, which were particularly used for winter waistcoats for the lords. Their cotton manufactures were equal to any produced in Europe; they wove them with different figures and colours, representing different animals and flowers. Of feathers interwoven with cotton they made mantles and bed-curtains, carpets, gowns, &c. These were exceedingly beautiful; but this kind of manufactory is now lost, though there are still some of these garments in the possession of the principal lords, who wear them upon solemn occasions.

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Manufac-
tures of dif-
ferent
kinds.

All these advances towards civilization, however, in the ancient Mexicans, were much more than counterbalanced by the horrible barbarities they committed in their religious ceremonies, and in which they exceeded every nation on earth. Human sacrifices were indeed in use among all the ancient heathens; but such prodigious massacres as have been already related at the dedication of their temples, are unheard of in history. Whether they used these barbarous sacrifices in their own country, or whether the practice began with that of the four Xochimilca prisoners, of whom we have already given an account, is not

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Their hor-
rible reli-
gion.

4 R

known;

¹⁷⁸ ^{Gladiatori-} ^{an sacrifice.} known; but as they only used their prisoners or slaves whom they bought in this way, it is impossible that, during the infancy of their state, the number of human victims could have been very great. Most of those unhappy creatures perished by having their breasts opened, and their hearts pulled out; some were drowned, others starved to death with hunger; and sometimes they were burnt. Prisoners of high rank were allowed to die by what Clavigero calls the *gladiatorial sacrifice*, which was performed in the following manner. Near to the greater temple of large cities, in an open space of ground sufficient to contain an immense number of people, was a round terrace eight feet high, upon which was placed a large round stone resembling a millstone in shape, but much larger, almost three feet high, well polished, and having figures cut upon it. On this stone, which was called *temalcatl*, the prisoner was placed, armed with a shield and short sword, and tied by one foot. Here he was encountered by a Mexican officer or soldier better armed than himself. If the prisoner was vanquished, he was carried, dead or alive, to the temple, where his heart was taken out and offered in the usual manner; but if he conquered six combatants, he gained his life and liberty. An instance, however, is given in which this custom was infringed; for the Huetzotzincas having taken the principal lord of Cholula, a man of singular bravery, he overcame seven combatants; notwithstanding which he was put to death; but on this account the Huetzotzincas were rendered forever infamous among these nations.

¹⁷⁹ ^{Number of} ^{human vi-} ^{ctims annu-} ^{ally sacri-} ^{ficed.} Historians differ concerning the number of victims who perished annually in these sacrifices: Clavigero inclines to think it was 20,000, but others make it much more. Zumarraga, the first bishop of Mexico, says in a letter of the 12th of June 1531, addressed to the general chapter of his order, that in that capital alone there were above 20,000 victims annually sacrificed. Some authors, quoted by Gomara, say that 50,000 were annually sacrificed in the various parts of the empire. Acosta says, that there was a certain day of the year on which they sacrificed 5000 victims, and another on which 20,000 were sacrificed. According to others they sacrificed, on the mountain Tepeyacac only, 20,000 annually to one of their female deities. On the other hand, Bartholomew de las Casas reduces the number of human victims to 50 or at most to 100. "We are strongly of opinion (says Clavigero), that all these authors have erred in the number; Las Casas by diminution, and the rest by exaggerating the truth."

¹⁸⁰ ^{Their mon-} ^{strous au-} ^{sterities.} Besides these cruelties which they practised upon others, the Mexicans were accustomed to treat themselves with the most inhuman austerities, thinking that the diabolical rage of their deities would be appeased by human blood. "It makes one shudder (says Clavigero), to read the austerities which they practised upon themselves, either in atonement for their transgressions, or in preparation for their festivals. They mangled their flesh as if it had been insensible, and let their blood run in such profusion as if it had been a superfluous fluid in the body. The effusion of blood was frequent and daily with some of their priests. They pierced themselves with the

sharpest spines of the aloe, and bored several parts of their bodies, particularly their ears, lips, tongue, and the fat of their arms and legs. Through the holes which they made with these spines they introduced pieces of cane, the first of which were small; but every time this penitential suffering was renewed a thicker piece was made use of. The blood which flowed from them was carefully collected in the leaves of the plant *aczojatl*. They fixed the bloody spines in little balls of hay, which they exposed upon the battlements of the walls of the temple, to testify the penance which they did for the people. Those who exercised such severities upon themselves within the inclosure of the greater temple of Mexico, bathed in a pond that was formed there, and which, from being always tinged with blood, was called *ezapan*."

¹⁸¹ ^{Their dress.} The dress of the Mexicans was very simple; that of the men consisted only of a large belt or girdle, the two ends of which hung down before and behind; the women wore a square mantle, about four feet long; the two ends were tied upon the breast or upon one shoulder. The Mexican gown was also a piece of square cloth, in which the women wrapped themselves from the waist down to the middle of the leg. They wore also a small under-vest or waistcoat without sleeves, named *bucpilli*.

The dress of the poorer sort was made of the thread of the mountain palm, or of coarse cotton; but those of better station wore the finest cotton embellished with various colours, and figures of animals or flowers; or woven with feathers, or the fine hair of the rabbit, &c. The men wore two or three mantles, and the women three or four vests, and as many gowns, putting the longest undermost, so that a part of each of them might be seen. Their shoes were only soles of leather, or coarse cloth of the mountain palm tied with strings; but those of the great people were adorned with ribbands of gold and jewels. They all wore long hair, and thought themselves dishonoured by being shaved, or having their hair clipped, except the consecrated virgins in the temple. The women wore it loose; but the men tied it up in different forms, and adorned their heads with fine feathers, both when they danced and went to war. With this simplicity, however, they mixed no small quantity of extravagance. Besides feathers and jewels, with which they used to adorn their heads, they wore ear-rings, pendants at their upper lip, as well as many at their noses, necklaces, bracelets for the hands and arms, as well as certain rings like collars which they wore about their legs. The ear-rings of the poor were shells, pieces of crystal, amber, &c.; but the rich wore pearls, emeralds, amethysts, or other gems, set in gold.

Instead of soap the Mexicans used a kind of fruit called *copalxocotl*; the pulp of which is white, viscous, and very bitter, makes water white, raises a froth, and will clean linen like soap. They used also a kind of root named *amolli*, which is not unlike the *saponaria* of the old continent. It is now more used for washing the body, especially the head, than for clothes. Clavigero says that there is a kind of this root which dyes the hair of a golden colour, and that he has been witness to this effect on the hair of an old man.

¹⁸² The principal inhabitants of Mexico, in modern times, are Spaniards sent hither by the court, to fill the ^{Modern in-} ^{habitants,} ^{&c.}

Mexico. the posts of government. They are obliged, like those in the mother-country who aspire to any ecclesiastical, civil, or military employments, to prove that there have been neither heretics, Jews, Mohammedans, nor any person in their family who have been called before the inquisition for four generations. Merchants who are desirous of going to Mexico, as well as to other parts of America, without becoming colonists, are compelled to observe the same forms. They are also obliged to swear that they have 300 palms of merchandise, their own property, in the fleet in which they embark, and that they will not carry their wives with them. On these absurd conditions they become the principal agents of the European commerce with the Indies. Though their charter is only to continue three years, and a little longer for countries more remote, it is of great importance. To them alone belongs the right of selling, as commissioners, the major part of the cargo. If these laws were observed, the merchants stationed in the new world would be confined to dispose of what they have received on their own account.

The predilection which administration has for Spaniards born in Europe, has reduced the Spanish Creoles to acquiesce in subordinate stations. The descendants of the companions of Cortes, and of those who came after them, being constantly excluded from all places of honour or of trust that were any way considerable, have seen the gradual decay of the power that supported their fathers. The habit of being obliged to bear that unjust contempt with which they have been treated, has at last made them become really contemptible. They have totally lost, in the vices which originate from indolence, from the heat of the climate, and from a superfluous enjoyment of all things, that firmness and that sort of pride which have ever characterised their nation. A barbarous luxury, shameful pleasures, and romantic intrigues, have enervated all the vigour of their minds, and superstition hath completed the ruin of their virtues. Blindly devoted to priests too ignorant to enlighten them by their instructions, too depraved to edify them by their example, and too mercenary to attend to both these duties of their function, they have no attachment to any part of their religion but that which enfeebles the mind, and have neglected what might have contributed to rectify their morals.

The Mestees, who constitute the third order of citizens, are held in still greater contempt. It is well known that the court of Madrid, in order to replenish a part of that dreadful vacancy which the avarice and cruelty of the conquerors had occasioned, and to regain the confidence of those who had escaped their fury, encouraged as much as possible the marriage of Spaniards with Indian women. These alliances, which became pretty common throughout all America, were particularly frequent in Mexico, where the women had more understanding and were more agreeable than in other places. The Creoles transferred to this mixed progeny the contemptuous slight they received from the Europeans. Their condition, equivocal at first, in process of time was fixed between the whites and the blacks.

These blacks are not very numerous in Mexico. As the natives are more intelligent, more robust, and

more industrious, than those of the other colonies, they have hardly introduced any Africans except such as were required either to indulge the caprice, or perform the domestic service, of rich people. These slaves, who are much beloved by their masters, on whom they absolutely depend, who purchased them at an extravagant price, and who make them the ministers of their pleasures, take advantage of the high favour they enjoy, to oppress the Mexicans. They assume over these men, who are called *free*, an ascendant which keeps up an implacable hatred between the two nations. The law has studied to encourage this aversion, by taking effectual measures to prevent all connection between them. Negroes are prohibited from having any amorous correspondence with the Indians; the men, on pain of being mutilated; the women, of being severely punished. On all these accounts, the Africans, who in other settlements are enemies to Europeans, are in the Spanish Indies their warm friends.

Authority has no need of this support, at least in Mexico, where population is no longer what it was formerly. The first historians, and those who copied them, have recorded, that the Spaniards found there 10,000,000 of souls. This is supposed to have been the exaggerated account of conquerors, to exalt the magnificence of their triumph; and it was adopted, without examination, with so much the more readiness, as it rendered them the more odious. We need only trace with attention the progress of those ruffians who at first desolated these fine countries, in order to be convinced that they had not succeeded in multiplying men at Mexico and the adjacent parts, but by depopulating the centre of the empire; and that the provinces which are remote from the capital, differed in nothing from the other deserts of South and North-America. It is making a great concession, to allow that the population of Mexico has only been exaggerated one-half: for it does not now much exceed 2,000,000.

It is generally believed, that the first conquerors massacred the Indians out of wantonness, and that even the priests incited them to these acts of ferocity. Undoubtedly these inhuman soldiers frequently shed blood without even an apparent motive; and certainly their fanatic missionaries did not oppose these barbarities as they ought to have done. This was not, however, the real cause, the principal source of the depopulation of Mexico; it was the work of a slow tyranny, and of that avarice which exacted from its wretched inhabitants more rigorous toil than was compatible with their constitution and the climate.

This oppression was coeval with the conquest of the country. All the lands were divided between the crown, the companions of Cortes, and the grandees or ministers who were most in favour at the court of Spain. The Mexicans, appointed to the royal domains, were destined to public labours, which originally were considerable. The lot of those who were employed on the estates of individuals was still more wretched. All groaned under a dreadful yoke; they were ill-fed; they had no wages given them; and services were required of them, under which the most robust men would have sunk. Their misfortunes excited the compassion of Bartholomew de las Casas.

Mexico.

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Mexicans
cruelly
treated by
the Spaniards.

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Bartholomew de las Casas takes their part.

Mexico.

This man, so famous in the annals of the new world, had accompanied his father in the first voyage made by Columbus. The mildness and simplicity of the Indians affected him so strongly, that he made himself an ecclesiastic, in order to devote his labours to their conversion. But this soon became the least of his attention. As he was more a *man* than a *priest*, he felt more for the cruelties exercised against them than for their superstitions. He was continually hurrying from one hemisphere to the other, in order to comfort the people for whom he had conceived an attachment, or to soften their tyrants. This conduct, which made him be idolized by the one and dreaded by the other, had not the success he expected. The hope of striking awe, by a character revered among the Spaniards, determined him to accept the bishoprick of Chiapa in Mexico. When he was convinced that this dignity was an insufficient barrier against that avarice and cruelty which he endeavoured to check, he abdicated it. It was then that this courageous, firm, disinterested man, accused his country before the tribunal of the whole universe. In his account of the tyranny of the Spaniards in America, he accuses them of having destroyed 15,000,000 of Indians. They ventured to find fault with the acrimony of his style; but no one convicted him of exaggeration. His writings, which indicate the amiable turn of his disposition, and the sublimity of his sentiments, have stamped a disgrace upon his barbarous countrymen, which time hath not, and never will, efface.

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In consequence of which their condition is rendered somewhat easier.

The court of Madrid, awakened by the representations of the virtuous Las Casas, and by the indignation of the whole world, became sensible at last, that the tyranny it permitted was repugnant to religion, to humanity, and to policy, and resolved to break the chains of the Mexicans. Their liberty was now only constrained by the sole condition, that they should not quit the territory where they were settled. This precaution owed its origin to the fear that was entertained of their going to join the wandering savages to the north and south of the empire.

With their liberty their lands ought also to have been restored to them; but this was not done. This injustice compelled them to work solely for their oppressors. It was only decreed, that the Spaniards, in whose service they laboured, should stipulate to keep them well, and pay them to the amount of 5 l. 5 s. a year.

From these profits the tribute imposed by government was subtracted, together with 4 s. 4 d. for an institution which it is astonishing the conquerors should have thought of establishing. This was a fund set apart in each community, and appropriated to the relief of such Indians as were decayed or indisposed, and to their support under private or public calamities.

The distribution of this fund was committed to their caciques. These were not the descendants of those whom they found in the country at the time of the conquest. The Spaniards chose them from among those Indians who appeared the most attached to their interests; and were under no apprehensions at making these dignities hereditary. Their authority was limited to the supporting the police in their district,

which in general extended eight or ten leagues; to the collecting the tribute of those Indians who laboured on their own account, that of the others being stopt by the masters whom they served; and to the preventing their flight by keeping them always under their inspection, and the not suffering them to contract any engagement without their consent. As a reward of their services, these magistrates obtained from government a property. They were permitted to take out of the common stock 2½ d. annually for every Indian under their jurisdiction. At last they were empowered to get their fields cultivated by such young men as were not yet subject to the poll tax; and to employ girls, till the time of their marriage, in such occupations as were adapted to their sex, without allowing them any salary except their maintenance.

These institutions, which totally changed the condition of the Indians of Mexico, irritated the Spaniards to a degree not to be conceived. Their pride would not suffer them to consider the Americans as free men; nor would their avarice permit them to pay for labour which hitherto had cost them nothing. They employed themselves successively, or in combination, craft, remonstrances, and violence, to effect the subversion of an arrangement which so strongly contradicted their warmest passions; but their efforts were ineffectual. Las Casas had raised up for his beloved Indians protectors who seconded his design with zeal and warmth. The Mexicans themselves, finding a support, impeached their oppressors before the tribunals; and even the tribunals that were either weak or in the interest of the court. They carried their resolution so far, as even unanimously to refuse to work for those who had treated any of their countrymen with injustice. This mutual agreement, more than any other circumstance, gave solidity to the regulations which had been decreed. The other, prescribed by the laws, was gradually established. There was no longer any regular system of oppression; but merely several of those particular vexations which a vanquished people, who have lost their government, can hardly avoid from those who have subdued it.

These clandestine acts of injustice did not prevent the Mexicans from recovering, from time to time, certain detached portions of that immense territory of which their fathers had been despoiled. They purchased them of the royal domain, or of the great proprietors. It was not their labour which enabled them to make these acquisitions: for this they were indebted to the happiness of having discovered some of them mines, others treasures, which had been concealed at the time of the conquest. The greatest number derived their resources from the priests and monks, to whom they owed their existence.

Even those who experienced a fortune less propitious, procured for themselves, by the sole profits of their pay, more conveniences than they had enjoyed before they underwent a foreign yoke. We should be very much deceived if we should judge of the ancient prosperity of the inhabitants of Mexico by what has been said of its emperor, its court, its capital, and the governors of its provinces. Despotism had there produced those fatal effects which it produces every-where. The whole state was sacrificed to the caprices,

Mexico.

Mexico. caprices, pleasures, and magnificence, of a small number of persons,

The government drew considerable advantages from the mines which it caused to be worked, and still greater from those which were in the hands of individuals. The salt-works greatly added to its revenue. Those who followed agriculture, at the time of harvest paid in a kind of a third of all the produce of the lands, whether they belonged to them as their own property, or whether they were only the farmers of them. Men who lived by the chase, fishermen, potters, and all mechanics, paid the same proportion of their industry every month. Even the poor were taxed at certain fixed contributions, which their labour or their alms might put them in a condition to pay.

The Mexicans are now less unhappy. Our fruits, our corn, and our cattle, have rendered their food more wholesome, agreeable, and abundant. Their houses are better built, better disposed, and better furnished. Shoes, drawers, shirts, a garment of wool or cotton, a ruff, and a hat, constitute their dress. The dignity which it has been agreed to annex to these enjoyments has made them better economists, and more laborious. This case, however, is far from being universal; it is even very uncommon in the vicinity of the mines, towns, and great roads, where tyranny seldom sleeps: but we often find it with satisfaction in remote parts, where the Spaniards are not numerous, and where they have in some measure become Mexicans.

The employments of this people are very various. The most intelligent, and those who are in easy circumstances, devote themselves to the most necessary and most useful manufactures, which are dispersed through the whole empire. The most beautiful manufactures are established among the people of Tlascalala. Their old capital, and the new one, which is called *Angelos*, are the centre of this industry. Here they manufacture cloth that is pretty fine, calicoes that have an agreeable appearance, certain slight silks, good hats, gold lace, embroidery, lace, glasses, and a great deal of hard-ware.

The care of flocks affords a maintenance to some Mexicans, whom fortune or nature have not called to more distinguished employments. America, at the time it was discovered, had neither hogs, sheep, oxen, horses, nor even any domestic animal. Columbus carried some of these useful animals to St Domingo, from whence they were generally dispersed, and at Mexico more than in any other place. These have multiplied prodigiously. They count their horned cattle by thousands, whose skins are become an object of considerable exportation. The horses are degenerated, but the quality is compensated by the number. Hog's lard is here substituted for butter. Sheep's wool is dry, coarse, and bad, as it is every where between the tropics.

The vine and olive-tree have experienced the same degeneracy. The cultivation of them was at first prohibited, with a view of leaving a free market for the commodities of the mother-country. In 1706, permission was given to the Jesuits, and a little afterwards to the marquis Del Valle, a descendant from Cortes,

to cultivate them. The attempts have not proved successful. The trials, indeed, that have been made, have not been abandoned; but no person has solicited the liberty of following an example which did not promise any great emoluments. Other cultures have been more successful. Cotton, sugar, silk, cocoa, tobacco, and European corn, have all thriven in some degree. The Spaniards are encouraged to prosecute the labours which these cultures require, from the happy circumstance of their having discovered iron mines, which were entirely unknown to the Mexicans, as well as some mines of a kind of copper that is hard enough to serve for implements of husbandry. All these articles, however, for want of men and industry, are merely consumed within the country.—There is only the vanilla, indigo, and cochineal, which make part of the trade of Mexico with other nations.

New-Mexico, so called because of its being discovered later than Old-Mexico, a country of America, is bounded on the north by high mountains, beyond which is a country altogether unknown; by Louisiana on the east; by New-Spain on the south; and on the west by the gulph of California, and the Rio Colorado; extending, it is said, above 100 miles from east to west, and about 900 from south to north; but the twentieth part of the country within these limits is neither cultivated nor inhabited either by Spaniards or Indians. As it lies in the midst of the temperate zone, the climate, in general, is very pleasant; the summers, though very warm, are neither sultry nor unwholesome; and the winters, though pretty sharp, are far from being insupportable, and, for the most part, clear and healthy.

The greatest encomiums are lavished on the fertility of the soil, the richness of the mines, and the variety of valuable commodities produced in this country. It is said to be beautifully diversified with fields, meadows, rising grounds, and rivers; abounding with fruit and timber-trees, turquoises, emeralds, and other precious stones, mines of gold and silver, a great variety of wild and tame cattle, fish and fowls. Upon the whole, we may safely affirm, that New-Mexico is among the pleasantest, richest, and most plentiful countries in America, or any other part of the world. There are few great or navigable rivers in it: the most considerable are, the Rio Solado and Rio del Norte, which, with several smaller streams, fall into the gulph of Mexico. On the coast of the gulph are divers bays, ports, and creeks, which might be easily converted into excellent harbours if the Spaniards were possessed of any portion of that commercial spirit which animates the other maritime nations of Europe.

The Spanish writers tell us, that New-Mexico is inhabited by a great variety of Indian nations or tribes, totally unconnected with each other: but the principal are the Apaches, a brave, warlike, resolute people; fond of liberty, and the inveterate enemies of tyranny and oppression. About the close of the last century, thinking themselves aggrieved by the Spanish government, they made a general insurrection, and did a great deal of mischief; but were at last obliged to submit, and have since been curbed by stronger garrisons. Most of the natives are now Christians. When

Mexico.

Mayer
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Mezeray.

the Spaniards first entered this country, they found the natives well clothed, their lands cultivated, their villages neat, and their houses built with stone. Their flocks also were numerous, and they lived more comfortably than most of the other savages of America. As to religion, they were idolaters, and worshipped the sun and moon; but whether they offered human sacrifices, we are not sufficiently informed.

As to the number of the provinces of this country, we can advance nothing certain; some writers making them only five, others 10, 15, 20, and 25; but adding no description, either of them or the towns contained in them, excepting the capital, Santa Fé, which we are told stands near the source of the Rio del Norte, in 36° of north latitude, and about 130 leagues from the gulph: that it is a well-built, handsome, rich town; and the seat of the bishop, suffragan of Mexico, as well as the governor of the province, who is subordinate to the viceroy of Mexico, or New-Spain.

MEYER (Felix), an eminent landscape painter, was born at Winterthur in 1653, and received his earliest instruction from a painter at Nuremberg: but he was afterwards a disciple of Ermels, a good landscape painter, whose manner he entirely followed.—In search of still greater improvement, however, he travelled to Italy: but the climate not agreeing with his constitution, he retired to Switzerland; where, as he was indefatigable in surveying all the beauty, the wildness, and magnificence of nature in those romantic scenes, he made a multitude of noble designs, which procured him very high reputation. As he was not expert at painting figures, those which he inserted in his own pictures being very indifferent, such of his landscapes as were supplied with figures by Roos or Rugendas, are accounted most estimable. He died in 1713.

MEYSENS (John), a painter of considerable eminence, was born at Brussels in 1612; and at first was taught the principles of painting by Anthony van Opstal, but afterwards he became a disciple of Nicholas vander Horst. When he commenced painter, he undertook both history and portrait: but the latter seems to have been his principal employment; and his reputation for that style of painting became very great throughout the Low Countries. His remarkable excellence consisted in his producing a very striking resemblance, in his finishing his pictures with a great deal of care, and in giving them a lively and good expression.

MEZERAY (Francis Eudicede), an eminent French historian, the son of Isaac Eudes a surgeon, was born at Rye, in Lower Normandy, in 1610; and took the surname of *Mezeray*, from a hamlet near Rye. Having performed his studies at Caen, he discovered a strong inclination to poetry; but going to Paris, he, by the advice of one of his friends, applied himself to the study of politics and history, and procured the place of commissary at war, which he held for two campaigns. He then shut himself up in the college of St Barbe, in the midst of books and manuscripts; and, in 1643, published the first volume of the History of France, in folio; and some years after, the other two volumes. Mezeray in that work surpassed all who had written the history of France before him, and was re-

warded by the king with a pension of 4000 livres. In 1668, he published an Abridgement of his History of France, in three volumes 4to, which was well received by the public: but as he inserted in that work the origin of most of the taxes with very free reflections, Mr Colbert complained of it, when Mezeray promised to correct what he had done in a second edition; but those corrections being only palliations, the minister caused half of his pension to be suppressed. Mezeray complained of this in very severe terms; when he obtained no other answer than the suppression of the other half. Vexed at this treatment, he resolved to write on subjects that could not expose him to such disappointments; and composed his treatise on the origin of the French, which did him much honour. He was elected perpetual secretary to the French academy; and died in 1683. He is said to have been a man extremely negligent in his person; and so careless in his dress, that he might have passed for a beggar rather than for what he was. He was actually seized one morning by the *archers des pauvres*, or parish-officers; which mistake was so far from provoking him, that he was highly diverted with it, and told them, that "he was not able to walk on foot, but that as soon as a new wheel was put to his chariot, he would attend them wherever they thought proper." He used to study and write by candle-light, even at noon-day in summer; and, as if there had been no sun in the world, always waited upon his company to the door with a candle in his hand. With regard to religion, he affected Pyrrhonism; which however was not, it seems, so much in his heart as in his mouth. This appeared from his last sickness: for having sent for those friends who had been the most usual witnesses of his licentious talk about religion, he made a sort of recantation, which he concluded with desiring them "to forget what he might formerly have said upon the subject of religion, and to remember, that Mezeray dying was a better believer than Mezeray in health." Besides his history, he also wrote, 1. A continuation of the history of the Turks. 2. A French translation of John de Sarisbury's Latin treatise on the vanities of the court. 3. There are attributed to him several satires against the government; and in particular, those that bear the name of *Sandricourt*.

MEZIERES, a strong town of France in Champagne, with a citadel. It was besieged with a powerful army by Charles V. who was obliged to raise the siege in 1521. It is seated on the river Meuse, partly upon a hill, and partly in a valley, in E. Long. 3. 48. N. Lat. 49. 46.

MEZIRIAC (Claude Gaspar Backet Sieur de), one of the most ingenious men of the 17th century, was born at Bresse, of an ancient and noble family. He was a good poet in French, Italian, and Latin; an excellent grammarian, a great Greek scholar, and an admirable critic. He was well versed in the controversies, both in philosophy and religion; and was deeply skilled in algebra and geometry, of which last he gave proof by publishing the six books of Diophantes, enriched with a very able Commentary and Notes. In his youth he spent a considerable time at Paris and at Rome: at which last place he wrote a small collection of Italian poems, in competition with Vaugelas, who was there at the same time; among which there are imitations

Mezeray
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Meziac.

Mezuzoth,
Mezzo-
tinto.

imitations of the most beautiful families contained in the eight first books of the *Æneid*. He also translated Ovid's *Epistles*; a great part of which he illustrated with very curious Commentaries of his own. While he was at Paris, they talked of making him preceptor of Louis XIII.: upon which he left the court in great haste, and afterwards declared that he had never felt so much pain upon any occasion of his life; for he seemed to have already upon his shoulders the important weight of the whole kingdom. He undertook the translation of all Plutarch's works, with notes; which he had brought nearly to a conclusion, when he died at Bourg, in Bresse, anno 1638, at 45 years of age. He left behind him several finished works, that were not printed.

MEZUZOTH, in the Jewish customs, certain pieces of parchment which the Jews fix to the door-posts of their houses, taking that literally which Moses commands them, saying, "Thou shalt never forget the laws of thy God, but thou shalt write them upon the posts of thy house, and on thy gates." This expression means nothing else, but that thou shalt always remember them, whether thou comest into thy house or goest out. But the Hebrew doctors imagined, that the lawgiver meant something more than this. They pretended, that, to avoid making themselves ridiculous, by writing the commandments of God without their doors, or rather to avoid exposing themselves to the profanation of the wicked, they ought at least to write them on a parchment, and to enclose it in something. Therefore they wrote these words upon a square piece of parchment prepared on purpose, with a particular ink, and a square kind of character. Deut. vi. 4, 5, 6, 7, 8, 9. "Hear, O Israel, the Lord our God is one Lord, &c."—Then they left a little space, and afterwards went on, Deut. xi. 13. "And it shall come to pass, if thou shalt hearken diligently to my commandments, &c." as far as, "Thou shalt write them upon the door-posts of thy house, &c." After this they rolled up the parchment, and put it into a case of reeds or other matter; they wrote on the end of the case the word *Shadai*, which is one of the names of God; and they put it at the doors of their houses, chambers, and all places most frequented; they fixed it to the knockers of the door, on the right side; and as often as they entered in or went out they touched it in this place, with the end of their finger, which they afterwards kissed out of devotion. The Hebrew word *mezuzah* properly signifies the door-posts of a house; but it is also given to this roll of parchment now mentioned.

MEZZOTINTO, a particular manner of representing figures on copper, so as to form prints in imitation of painting in Indian ink. See ENGRAVING.

The invention of this art has been usually attributed to prince Rupert. But Baron Heinikin, a very judicious and accurate writer upon the subject of engraving, asserts, with great appearance of truth, that it was a lieutenant-colonel de Siegan, an officer in the service of the landgrave of Hesse, who first engraved in this manner; and that the print which he produced was a portrait of the princess Amelia Elizabeth of Hesse, engraved in the year 1643. Prince Rupert learned the secret from this gentleman, and brought

it into England when he came over the second time with Charles II. Prince Rupert's print of An Executioner holding a Sword in one Hand and a Head in the other, a half length, from Spagnoletto, is dated 1658. This art has never been cultivated with success in any country but England.

The prince laid his grounds on the plate with a channelled roller; but one Sherwin, about the same time, laid his grounds with a half-round file, which was pressed down with a heavy piece of lead. Both these grounding tools have been laid aside for many years; and a hand-tool, resembling a shoemaker's cutting-board-knife, with a fine crenelling on the edge, was introduced by one Edial, a smith by trade, who afterwards became a mezzotinto painter.

It is very different from the common way of engraving. To perform it, they rake, hatch, or punch, the surface of the plate all over with a knife, or instrument made for the purpose, first one way, then the other, across, &c. till the surface of the plate be thus entirely furrowed with lines or furrows, close and as it were contiguous to each other; so that, if an impression was then taken from it, it would be one uniform blot or smut. This done, the design is drawn or marked on the same face; after which, they proceed with burnishers, scrapers, &c. to expunge and take out the dents or furrows, in all the parts where the lights of the piece are to be; and that more or less as the lights are to be stronger or fainter; leaving those parts black which are to represent the shadows or deepennings of the draught.

As it is much easier to scrape or burnish away parts of a dark ground corresponding with the outline of any design sketched upon it, than to form shades upon a light ground by an infinite number of hatches, strokes, and points, which must all terminate with exactness on the outline, as well as differ in their force and manner; the method of scraping, as it is called, in mezzotinto, consequently becomes much more easy and expeditious than any other method of engraving. The instruments used in this kind of engraving are cradles, scrapers, and burnishers.

In this engraving, the plate must be prepared and polished in the same manner as for other engraving; and afterwards divided equally by lines parallel to each other, and traced out with very soft chalk.—The distance of these lines should be about one-third of the length of the face of the cradle which is to be used, and these lines should be marked with capital letters, or strokes of the chalk. The cradle is then to be placed exactly betwixt the two first lines, and passed forwards in the same direction; being kept as steady as possible, and pressed upon with a moderate force. The same operation must be repeated with respect to all the other lines; till the instrument has thus passed over the whole surface of the plate.—Other lines must be then drawn from the extremities of the other two sides, in the same manner; which, intersecting the first at right angles, will with them form squares; and the same operation must be repeated with the cradle as in the case of the first. New lines must then be drawn diagonally, and the cradle passed betwixt them as before; and when the first diagonal operation is performed, the lines must be crossed at right angles as the former, and the cradles

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cradles passed betwixt them in the same manner.— The plate having undergone the action of the cradle, according to the disposition of the first order of lines, a second set must be formed, having the same distances from each other as the first. But they must be so placed as to divide those already made into spaces one-third less than their whole extent; *i. e.* every one after the first on each side will take in one-third of that before it, *e. g.* beginning at A, of which the first third must be left out; a third of B will consequently be taken in, and so of the rest. These lines of the second order must be marked with small letters, or lesser strokes to distinguish them from the first: and the same treatment of the plate must be pursued with respect to them as was practised for the others. When this second operation is finished, a third order of lines must be made; the first of which, *e. g.* in A, must omit two-thirds of it, and consequently take in two-thirds of B, &c. By these means, the original spaces will be exactly divided into equal thirds; and the cradle must be again employed betwixt these lines as before.— When the whole of this operation is finished, it is called *one turn*; but in order to produce a very dark and uniform ground, the plate must undergo the repetition of all these several operations for above twenty times; beginning to pass the cradle again betwixt the first lines, and proceeding in the same manner through all the rest. When the plate is prepared with a proper ground, the sketch must be chalked on it, by rubbing the paper on the backside with chalk. It is also proper to overtrace it afterwards with black lead or Indian ink. The scraping is then performed, by pairing or cutting away the grain of the ground in various degrees; so that none of it is left in the original state except in the touches of the strongest shade. The general manner of proceeding is the same as drawing with white upon black paper. The masses of light are first begun with; and those parts which go off into light in their upper part, but are brown below: the reflections are then entered upon; after which the plate is blackened with a printer's blacking-ball made of felt, in order to discover the effect: and then the work is proceeded with; observing always to begin every part in the places where the strongest lights are to be.

The art of scraping mezzotintoes has been applied to the printing with a variety of colours, in order to produce the resemblance of paintings. The inventor of the method of doing this was J. C. Le Blon, a native of Frankfort, and pupil of Carlo Maratta, between the years 1720 and 1730. It was established by the inventor on this principle, that there are three primitive colours, of which all the rest may be composed by mixing them in various proportions; that any two of these colours being mixed together, preserve their original power, and only produce a third colour such as their compound must necessarily give; but if transparent colours be mixed, and three primitive kinds compounded together, they destroy each other, and produce black, or a tendency to it, in proportion to the equality or inequality of the mixture; and that if, therefore, these three colours be laid, either separately or upon each other, by three plates, engraved correspondently on these principles to the colouring of the design, the whole variety of tints necessary may be pro-

duced. The requisites, therefore, to the execution of any design in this method of printing are as follow: 1. To settle a plan of the colouring to be imitated; showing where the presence of each of the three simple colours is necessary, either in its pure state or combined with some other, to produce the effect required; and to reduce this plan to a painted sketch of each, in which not only the proper outlines, but the degree of strength, should be expressed. 2. To engrave three plates according to this plan, which may print each of the colours exactly in the places where, and proportion in which, they are wanted. 3. To find three transparent substances proper for printing with these three primitive colours. The manner in which Mr Le Blon prepared the plates was as follows: The three plates of copper were first well fitted with respect to size and figure to each other, and grounded in the same manner as those designed for mezzotinto prints: and the exact place and boundary of each of the three primitive colours, conformably to the design, were sketched out on three papers, answering in dimensions to the plate. These sketches were then chalked on the plates; and all the parts of each plate that were not to convey the colour to which it was appropriated to the print, were entirely scraped away, as in forming the light of mezzotinto prints. The parts that were to convey the colours were then worked upon; and where the most light or diluted tints of the colour were to be, the grain in the ground was proportionably taken off; but where the full colour was required, it was left entire. In this regard was had, not only to the effects of the colour in its simple state, but to its combined operation, either in producing orange-colour, green, or purple, by its admixture with one alone; and likewise to its forming brown, grey, and shades of different degrees, by its co-operation with both the others. But though the greatest part of the engraving was performed in the mezzotinto manner, yet the graver was employed occasionally for strengthening the shades, and for correcting the outline where it required great accuracy and steadiness. It was found necessary sometimes to have two separate plates for printing the same colour, in order to produce a stronger effect: but the second plate, which was used to print upon the first, was intended only to glaze and soften the colours in particular parts that might require it. With respect to the black and brown tints, which could not be so conveniently produced in a due degree by the mixture of the colours, umber and black were likewise used.

With respect to the order in which the plates are to be applied, it may be proper to observe, that the colour which is least apparent in the picture should be laid on first; that which is betwixt the most and least apparent next; and that which predominates last; except where there may be occasion for two plates for the same colour, as was before-mentioned; or where there is any required for adding browns and shades.

Mr Le Blon applied this art to portraits, and showed, by the specimens he produced, the possibility of its being brought, by farther improvements, to afford imitations of painting which might have some value. It is nevertheless much better adapted to the simpler

Miasma,
Mica.

Mica.

subjects, where there are fewer intermixtures of colours; and where the accuracy of the reflections, and demi-tints, are not so essentially necessary to the truth of the design, from the greater latitude of form, and disposition of the colour, as in plants, anatomical figures, and some subjects of architecture. But perhaps plates engraved or rather finished with the tool, particularly with respect to the outline, would be better accommodated in some of these cases than those prepared only by scraping.

Mr Cochin remarks, at the end of an account he has given of Mr Le Blon's manner, that though this ingenious artist confined his method principally to the use of three colours; yet, should this invention be again taken up and cultivated, there would be more probability of success in using a greater variety: and that several different kinds might be printed by one plate; provided they were laid on in their respectively proper places by printing-balls, which should be used for that colour only. His hint might however be very greatly improved, by the further assistance of pencils, accommodated to the plates, for laying on the colours in the proper parts.—For the method of taking off mezzotinto prints on glass, see *BACK-painting*.

MIASMA, among physicians, a particular kind of effluvia, by which certain fevers, particularly intermittents, are produced.

MICA, DAZE, *Talc*, *Muscovy-glass*, *Glimmer*, or *Glist*; a genus of magnesian earths, known by the following characters: 1. They consist of thin flexible particles, divisible into plates or leaves, having a shining surface. 2. These leaves or scales, exposed to the fire, lose their flexibility and become brittle, separating afterwards into thinner leaves: but in a quick and strong fire they curl or crumple, which is a step towards fusion; though it is very difficult to reduce them into pure glass without addition. 3. They melt easily with borax, the microcosmic salt, and alkaline salt; and, by means of the two former salts, may be brought to a clear glass before the blow-pipe. That which contains iron, however, is more fusible than the uncoloured earths of this kind. No loose or friable mica has yet been discovered, but all of an indurated kind. Its specific gravity, according to Fabroni, is about 3000. Kirwan tells us, that the specific gravity of this substance, when it contains much iron, is from 2535 to 3000. An hundred parts of the colourless kind contain 38 of silice, 28 of argill, 20 of magnesia, and 14 of the most dephlogisticated calx of iron. Martial mica contains also 10 or 12 per cent. of a more phlogisticated calx of iron; whence its various colours are derived, and a proportionably smaller quantity of the other ingredients. The species are,

I. Mica alba, colourless or pure mica; of which there are the following varieties. 1. Muscovy glass, consisting of large parallel plates, and as transparent as glass, found in Siberia and Sweden. This differs externally from the common talc, in being more soapy to the touch. An hundred parts of it contain 50 of silice, 45 of mild magnesia, and 5 of argill or clay. Venetian talc is white, grey, yellowish, or greenish, and semitransparent. It is much more tender and brittle than mica, and so soft that it may be scratched with the nail. Its specific gravity is 2729 2. Mica

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squamosa, composed of small plates, found in Sweden and other countries of Europe. 3. Composed of fine particles like chaff. 4. Talcum officinale, crumpled mica, composed of crumpled plates.

II. Mica colorata martialis, coloured and martial glimmer. Of this there are many varieties. 1. Brown and semitransparent, found in Lapland. 2. Consisting of fine and minute scales, of a brown, deep-green, light-green, or black colour, found in different parts of Sweden. 3. Twisted or crumpled glimmer, of a light green colour, found also in Sweden. 4. Chaffy glimmer, of a black colour, found in the stone called *hornberg*, occurring in most of the Swedish copper mines, as at Norberg, Flodberg, &c. 5. Crystallized glimmer, with erect scales, or with hexagonal horizontal plates, found also in Sweden.

Most of these stones are supposed absolutely to resist the fire; but this is to be understood only of certain degrees of heat, and when they are mixed with certain bodies. Cronstedt observes, however, that they may with equal propriety be called *vitrescent*; because they melt with that degree of heat in which neither quartz nor limestone are in the smallest degree altered. They are still more readily melted when either naturally or artificially combined with a martial earth. Hence some ores, though much mixed with mica, may be very readily melted; while others, in which the same substance is mixed with quartz, it may be impossible to melt; because the mica renders the quartz so compact as to prevent it from cracking. It does the same with an apyrous clay, which is the reason why the lapis ollaris resists the fire so strongly.

M. Margraaf asserts, that he has obtained Epsom salt from talc; and Mr Fabroni informs us, that in decomposing nitre by means of a micaceous substance, as soon as the acid is distilled there rises some other substance hitherto unknown at the end of the operation: he adds, that on employing aqua regia or marine acid to dissolve this substance, the yellow colour which results from the solution shows that it contains some iron. This last assertion is confirmed by M. Monnet, who found that phlogisticated alkali and solution of galls produce a bluish colour with that of mica. He adds, that its component parts are the same with those of asbestos, excepting only that the latter contains more iron.

Cronstedt informs us, that the martial mica acquires a shining yellow colour in a calcining heat, which has induced many to examine it in hopes of finding gold; though no metal can be obtained from it except iron, which may be dissolved by means of aqua regia. A late German author indeed has pretended, that he produced from mica an unknown semimetal which resembled iron mixed with zinc. He owned, however, that he made use of a flux composed of several metals, some of which probably united with the talc, and thus deceived him. The talc cubes, which are micaceous bodies of the figure of aluminous crystals, are much valued and sought after by some mineralogists. They are met with in some parts of Sweden; and when broken are found to consist of an iron ore frequently mixed with a marcasitical copper ore, and are only covered with a very thin coat of mica. The broad and transparent talc named *Muscovy-glass* is used instead of

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glass

Micah,
Michael.

glass for windows; and has this advantage above common glass, that it resists the explosion of cannon. Cronstedt thinks that it might be advantageously used for covering houses. The twisted or crumpled mica, found in some places of Sweden, is manufactured into kettles and other vessels, likewise into hearths for chimneys; "and the powder which falls in the working (says our author) may be mixed with the common salt for the distillation of the muriatic acid."

According to M. Magellan, many mineral substances may have the glittering appearance of talc without really belonging to that genus. An artificial production of this kind he happened to observe in Mr Wedgewood's work. It was an unexpected result from vitriol calcined to redness, then mixed without being washed with common salt. It now underwent a second calcination under a muffle, with a heat somewhat stronger; about the tenth degree of his thermometer. The colour was of a dark purple, and the shining particles so bright as to show their glassy form, very different from true mica.

MICAH, or *The Book of MICAHA*, a canonical book of the Old Testament, written by the prophet Micah, who is the seventh of the twelve lesser prophets. He is cited by Jeremiah, and prophesied in the days of Jotham, Ahaz, and Hezekiah. He censures the reigning vices of Jerusalem and Samaria, and denounces the judgments of God against both kingdoms. He likewise foretells the confusion of the enemies of the Jews, the coming of the Messiah, and the glorious success of his church.

MICHAEL, or MICHEL, (i. e. *who is like to God*?) The scripture account of Michael is, that he was an archangel, who presided over the Jewish nation, as other angels did over the Gentile world, as is evident of the kingdoms of Persia and Greece, (Dan. x. 13.); that he had an army of angels under his command (Rev. xii. 7.); that he fought with the Dragon, or Satan and his angels; and that, contending with the Devil, he disputed about the body of Moses, (Jude 9.) As to the combat between Michael and the Dragon, some authors understand it literally, and think it means the expulsion of certain rebellious angels, with their head or leader, from the presence of God. Others take it in a figurative sense; and refer it, either to the contest that happened at Rome between St Peter and Simon Magus, in which the apostle prevailed over the magician, or to those violent persecutions under which the church laboured for three hundred years, and which happily ceased when the powers of the world became Christians. Among the commentators who maintain the former opinion is Grotius; and among those who take it in a figurative sense are Hammond and Mede.

The contest about the body of Moses is likewise taken both literally and figuratively. Those who understand it literally are of opinion, that Michael by the order of God hid the body of Moses after his death; and that the Devil endeavoured to discover it, as a fit means to entice the people to idolatry, by a superstitious worship of his relics. But this dispute is figuratively understood to be a controversy about rebuilding the temple, and restoring the service of God among the Jews at Jerusalem; the Jewish church being fitly enough styled the body of Moses. It is thought by

some, that this story of the contest between Michael and the Devil was taken by St Jude out of an apocryphal book called, *The Assumption of Moses*.

The Romish church celebrates three appearances of Michael, of which no mention is made in scripture, and which have happened, they say, a long time after the age of the apostles. The first appearance of this archangel was at Colossæ in Phrygia, but at what time is uncertain. The second is that of mount Garganus, in the kingdom of Naples, about the end of the fifth century. The third is his appearance to Aubert bishop of Avranches, upon a rock called the *Tomb*, where at this day is the abbey of St Michael. This was about the year 705. The first of these festivals is observed on the 6th of September, the second on the 8th of May, and the last on the 16th of October. It has been supposed, that it was Michael the archangel who conducted the Israelites in their journey through the wilderness, (see Ex. xxxii. 20, 23, and xxxiii. 2.); that it was he who appeared to Moses in the burning bush; who appeared to Joshua in the fields of Jericho, and to Gideon and Manoah the father of Samson; and, in a word, to him have been imputed the greatest part of the most remarkable appearances either in the Old or New Testament.

MICHAEL ANGELO. See ANGELO.

Mount MICHAEL, one of the most celebrated state-prisons of France, lies about 20 miles from Granville. It is a rock situated in the middle of the bay of Avranches; and is only accessible at low water. Nature has completely fortified one side, by its craggy and almost perpendicular descent, which renders it impracticable to mount it by any address or courage, however consummate. The other parts are surrounded by walls fenced with semilunar towers after the Gothic manner; but sufficiently strong, together with the advantage of its situation, to render it impregnable to any attack. At the foot of the mountain begins a street or town, which winds round its base to a considerable height. Above are chambers where state-prisoners are kept, and where there are other buildings intended for residence. On the summit is erected the abbey itself, occupying a prodigious space of ground, and of a strength and solidity equal to its enormous size; since it has for many centuries withstood all the injuries of the weather, to which it is so much exposed. In an apartment, called the *Salle de Chavalerie*, the knights of St Michael used to meet in solemn convocation on important occasions. They were the defenders and guardians of this mountain and abbey, as those of the temple, and of St John of Jerusalem, were of the holy sepulchre. The hall in which they met is very spacious, but rude and barbarous. At one end is a painting of the archangel, the patron of their order; and in this hall Louis XI. first instituted and invested with the insignia of knighthood the chevaliers of the cross of St Michael. There is a miserable dark apartment, or rather dungeon, in which many eminent persons were formerly confined. In the middle of it is a cage, composed of prodigious bars of wood; and the wicket which gives entrance into it is 10 or 12 inches in thickness. The inside of it comprises about 12 or 14 feet square, and it is nearly 20 in height. Towards the latter end of the last century, a certain newswriter in Holland, who had presumed to print some

Michael

Michael. very severe and sarcastic reflections on Madame de Maintenon, was confined in this place. Some months after his publication, he was induced, by a person sent expressly for that purpose, to make a tour into French Flanders. The moment he had quitted the Dutch territories, he was put under arrest; and immediately, by his majesty's express command, conducted to Mount Michael, where he was shut up in this cage. Here he lived upwards of 23 years; and here he at length expired. During the long nights of winter, no candle or fire was allowed him. He was not permitted to have any book. He saw no human face, except the gaoler, who came once every day to present him, through a hole in the wicket, with his little portion of bread and wine. No instrument was given him with which he could destroy himself; but he found means at length to draw out a nail from the wood, with which he engraved, or cut on the bars of his cage, certain fleurs de lis and armorial bearings, which formed his only employment and recreation. They are very curiously performed considering the rudeness of his tool.

The subterraneous chambers in this mountain are said to be so numerous, that the gaolers themselves do not know them. There are certain dungeons called *aubliettes*, into which they were accustomed anciently to let down malefactors guilty of very heinous crimes: they provided them with a loaf of bread and a bottle of wine, and then they were totally forgotten, and left to perish by hunger in the dark vaults of the rock. This punishment, however, has not been inflicted by any king in the last or present century.

Here also is a remarkable chamber, in one corner of which is a kind of window; between this and the wall of the building is a very deep space, of near 100 feet perpendicular, at the bottom of which is another window opening to the sea. It is called the *Hole of Montgomeri*; and the history of it is as follows: In the year 1559, Henry II. king of France was unfortunately killed at a tournament by the count de Montgomeri †. He was a Huguenot; and having escaped the massacre of Paris, made head against the royal forces in Normandy, supported by queen Elizabeth with arms and money. Being driven from his fortresses in these parts, he retired to a rock called the *Tombelaine*. This is another similar to Mount Michael; only three quarters of a league from it, and of nearly equal dimensions. At that time there was a castle upon it, which has since been demolished, and of which scarce any vestiges now remain. From this fortress, accessible only at low-water, he continually made excursions, and annoyed the enemy, who never dared to attack him. He coined money, laid all the adjacent country under contribution, and rendered himself universally dreaded. Desirous, however, to surprise Mount Michael, he found means to engage one of the monks resident in the abbey; who promised to give him the signal for his enterprise by displaying a handkerchief. The monk having made the signal, betrayed him, and armed all his associates, who waited Montgomeri's arrival. The chieftain came, attended by 50 chosen soldiers, all desperate, and capable of any attempt. They crossed the sand; and having placed their scaling ladders, mounted one by one. As they came to the top, they were dispatched, each in turn, without noise. Montgomeri, who followed last, discovered the per-

fidy, and escaped with only two of his men, with whom he regained the Tombelaine. They preserve with great care the ladders and grappling irons used on this occasion. The count was at last besieged and taken prisoner by the marshal de Matignon, in 1574, at Domfront, in Normandy; and Catharine de Medicis, who hated him for having been, though innocently, the cause of her husband's death, caused him to be immediately executed.

The church of Mount Michael is a great curiosity. It stands on nine pillars of most enormous dimensions, built on the solid rock. Each of them appears to be about 25 feet in circumference: besides these, there are two others much inferior in size, on which the centre of the church rests, and over which is the tower. The following is the legendary account of the origin of this church: In the reign of Childebert II. there was a bishop of Avranches named *St Aubert*. To this holy man the archangel Michael was pleased to appear one night, and ordered him to go to this rock to build a church. *St Aubert* treated this as a dream; upon which the angel appeared a second time; and being still disobeyed, he returned a third time, when, by way of imprinting his command upon the saint's memory, he made a hole in his skull, by touching it with his thumb. The skull is still preserved in the treasury of the church. It is inclosed in a little shrine of gold, and a crystal, which opens over the orifice, admits the gratification of curiosity by the minutest examination of it. The hole is of a size and shape proportionable to the thumb said to have produced it; but it is impossible to determine whether it has been really made by a knife or any other way. It is not to be supposed that the saint would forget such a sensible mark of the angel's displeasure; he therefore immediately repaired to the rock, and constructed a small church, as he had been commanded. Here, however, true history supplies the place of fable; and informs us, that it was in 966 when Richard the second duke of Normandy began to build the abbey. It was completed about the year 1070, under William the Conqueror, though many other additions were made by succeeding abbots.

In the treasury of the church are innumerable other relics; among which some few have a real and intrinsic value. There is a fine head of Charles VI. of France, cut in a crystal, and the representation of a cockle-shell in gold, weighing many pounds, given by Richard II. duke of Normandy, when he founded the abbey. There is an arm said to belong to *St Richard* king of England; but who this saint was it must be very difficult to determine.

ST MICHAEL'S, a borough town of Cornwall, between St Columb and Truro, 247 miles from London. Though one of the oldest boroughs in the county by prescription, and of great note in the Saxons time, it is a mean hamlet in the parishes of Newland and St Enidore; yet it is governed by a portreeve, yearly chosen by a jury of the chief inhabitants, out of the six chief tenants, called deputy lords of the manor, because they hold lands in the borough. Here is no market, but two fairs. A court-leet is held here twice a year. This place was formerly called Modishole, and afterwards Michel. Its list of members begins in the 6th of Edward VI.

St MICHAEL'S Mount, in the county of Cornwall, in the corner of Mount's-Bay, is a very high rock,

Michael,
St Michael's.

† See
France,
no 140.

Michaelis. only divided by the tide from the main-land, so that it is land and island twice a-day. The town here was burnt by the French in the reign of king Henry VIII. At the bottom of this mount, in digging for tin, there have been found spear-heads, battle axes, and swords, of brass, all wrapt up in linen. The county is contracted here into a sort of isthmus, so that it is scarce four miles between the Channel and the Severn sea.—There have been large trees driven in by the sea between this mount and Penzance.

MICHAELIS (John David), a celebrated biblical critic, and author of many esteemed works, was the eldest son of Dr Christian Benedict Michaelis, professor in the university of Halle in Lower Saxony, and was born at that place Feb. 27. 1717. His father devoted him at an early age to an academical life; and with that view he received the first part of his education in a celebrated Prussian seminary, called the *Orphan-house*, at Glanche, in the neighbourhood of his native place. He commenced his academical career at Halle in 1733, and took his master's degree in the faculty of philosophy in 1739. In 1741 he made an excursion to this country, where his superior knowledge of the oriental languages, which was considerably increased by his indefatigable researches in the Bodleian library at Oxford, introduced him to the acquaintance, and gained him the esteem, of our first literary characters; with several of whom, and particularly bishop Lowth, he was in correspondence for many years. On his return to Halle, after an absence of fifteen months, he began to read lectures on the historical books of the Old Testament, which he continued after his removal to Gottingen in 1745. In 1746 he was appointed professor extraordinary, and soon after professor of philosophy, in that university. The next year he obtained a place of secretary to the royal society there, of which he was director in 1761, and was soon afterwards made Aulic counsellor by the court of Hanover. In 1764 his distinguished talents, but chiefly a publication relative to a journey to Arabia, which was undertaken by several literary men, at the expence of the king of Denmark, in consequence of his application by means of Count Bernsdorff, procured him the honour of being chosen a correspondent, and afterwards foreign member, of the academy of inscriptions at Paris, of whom the institution admitted only eight; and in the same year he became a member of the society of Haarlem. In 1775, Count Hopkin, who eighteen years before had prohibited the use of his writings at Upsal, when he was chancellor of that university, prevailed upon the king of Sweden to confer on him the order of the polar star, as a national compensation. In 1786 he was raised to the distinguished rank of privy counsellor of justice by the court of Hanover; and in 1788 received his last literary honour, by being unanimously elected a fellow of the royal society of London.—His great critical knowledge of the Hebrew language, which he displayed in a new translation of the Bible, and in other works, raised him to a degree of eminence almost unknown before in Germany; and his indefatigable labours were only equalled by his desire of communicating the knowledge he acquired to the numerous students of all countries who frequented his admirable lectures, which he continued to deliver on various parts of the sacred writings in half-yearly courses,

and on the Hebrew, Arabic, and Syriac languages, to the last year of his life. He was professor in the university of Gottingen forty-five years, and, during that long period, he filled the chair with dignity, credit, and usefulness. He died October 22. 1791, aged 74. He is said to have left behind him several valuable MSS. Of the works that were published during his life-time, and which are very numerous, a catalogue, in the order of their publication, is given in the *Gentleman's Magazine* for March 1792.

MICHAELMAS, or *Feast of St MICHAEL and all Angels*, a festival of the Christian church, observed on the 29th of September. See **MICHAEL**.

MICKLE (William Julius), the celebrated translator of the *Lusiad*, was the son of the reverend Alexander Mickle a Scottish clergyman, who had formerly been a dissenting minister in London, an assistant to the reverend Dr Watts, and one of the translators of Bayle's Dictionary. This gentleman having resided a few years in London, was presented to the church of Langholm near Kelso in Scotland, where he married; and our author was one of the younger sons. He was born about the year 1735, and was educated by his father. In his early years his passion for poetry frequently discovered itself; though till the age of 13 he did not show any particular attachment to books. At that time having accidentally met with Spencer's *Fairy Queen*, he became enamoured of his manner of writing, and instantly began to imitate him. After the death of his father, he came to Edinburgh to reside with an uncle who was a brewer there, and who admitted him into a share of his business; but not being qualified to succeed in this line, he went to London about the time of the conclusion of the war which began in 1755, with a view to procure a commission in the marine service. Here he was disappointed; but introduced himself to the first Lord Lyttelton, to whom he sent one of his poems. From his lordship, however, he received no other favour than being admitted to several interviews, and encouraged to persevere in his poetical plans.

So closely did our author cultivate the study of the muses, that before he was 18 years of age he had written two tragedies and half an epic poem; but all these were committed to the flames. The first of his poems which appeared in print was published in one of the Edinburgh magazines, and intitled, "On passing thro' the Parliament Close of Edinburgh at Midnight." This was afterwards inserted in *A Collection of Original Poems by a Scotch gentleman*, Vol. II. p. 137.

From the time of Mr Mickle's arrival at London till the year 1765, it is not known how he employed his time, though it is probable that he was employed in some branch of the printing business; and in 1765 he engaged himself as corrector to the Clarendon press. This year he published the poem which first brought him into notice, intitled, "Pollio, an Elegiac Ode, written in the Wood near R—— (Roslin) Castle," 4to. This was an elegy written on the death of his brother; which, previous to its publication, had been shown to Lord Lyttelton, and received some corrections from him. The latter, in an epistle to the author, spoke of it as equal to any thing of the kind in our language. In 1767 he published a poem called "The Concubine, in two Cantos, after the manner of

Spencer,"

MICROMETER.

Fig. 1.

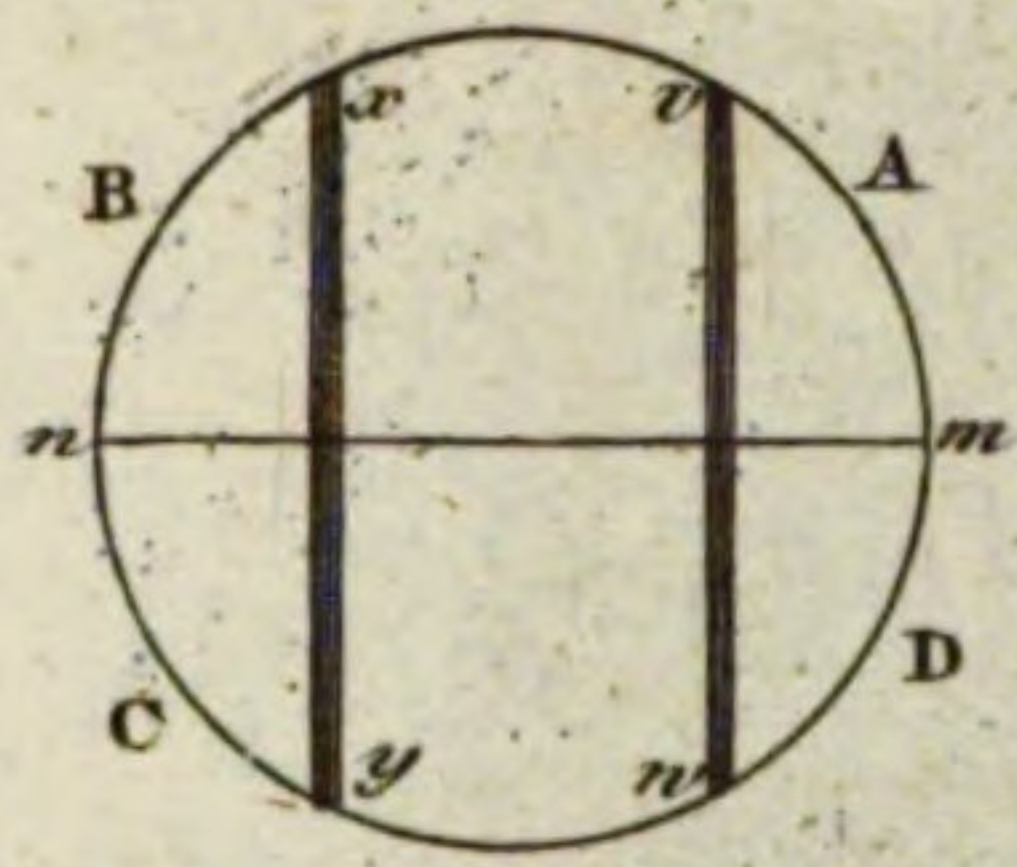


Fig. 3.

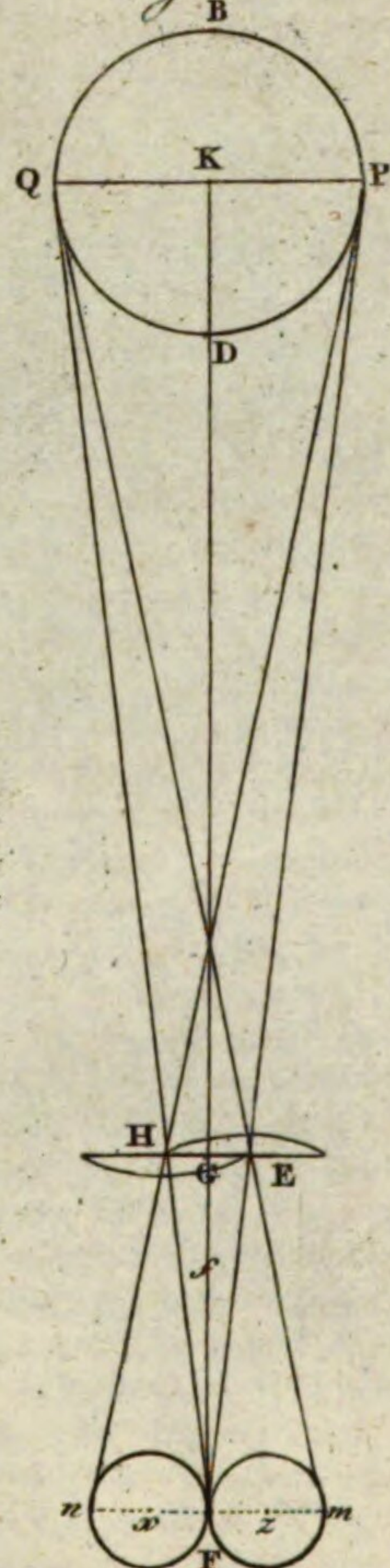


Fig. 8.

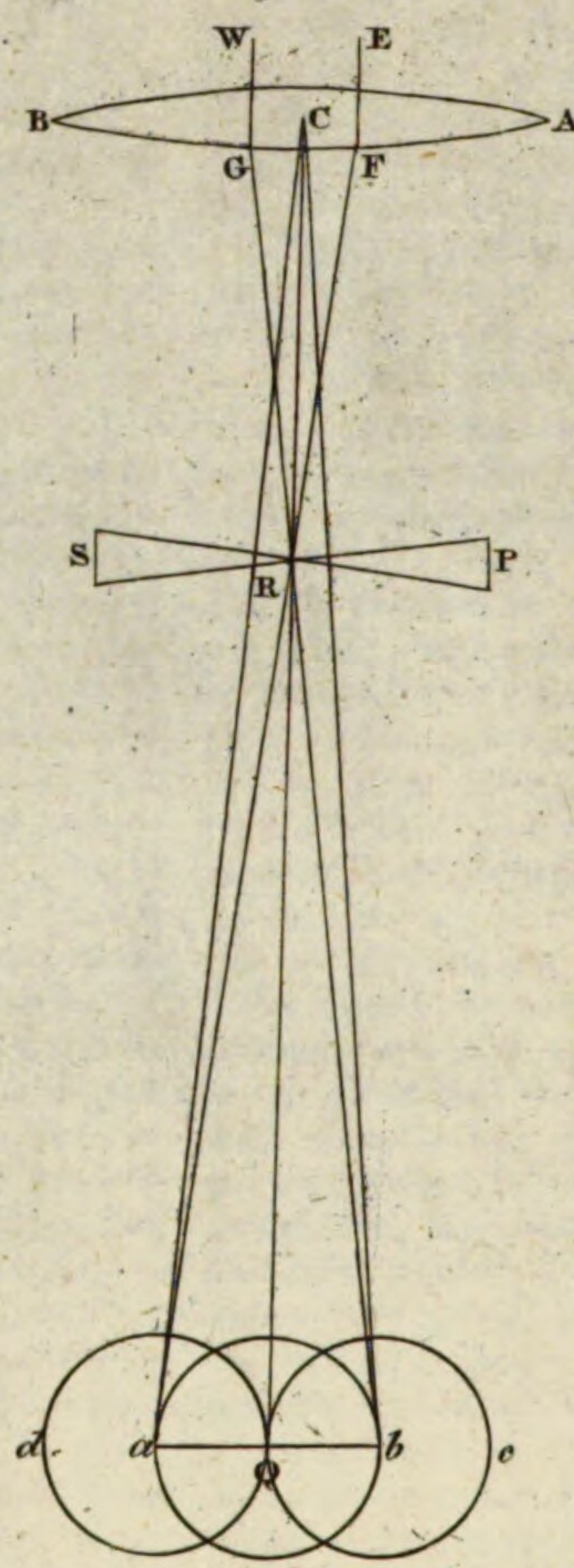


Fig. 9.

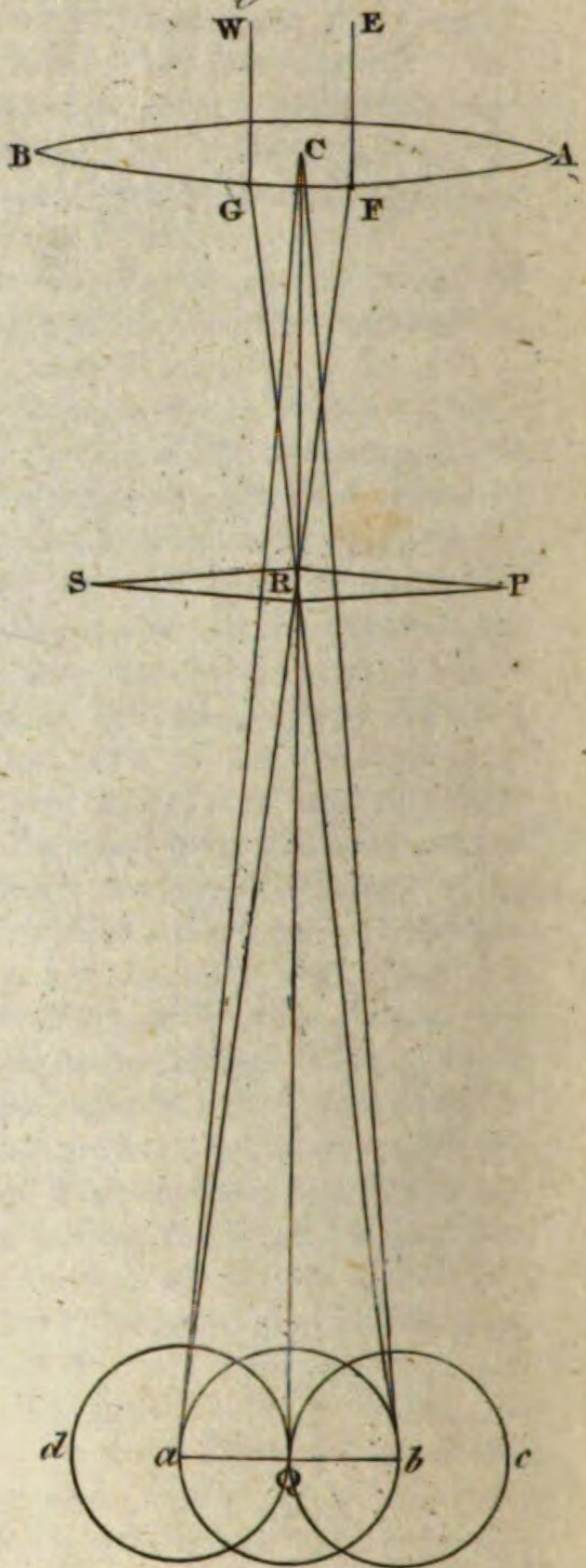


Fig. 4.

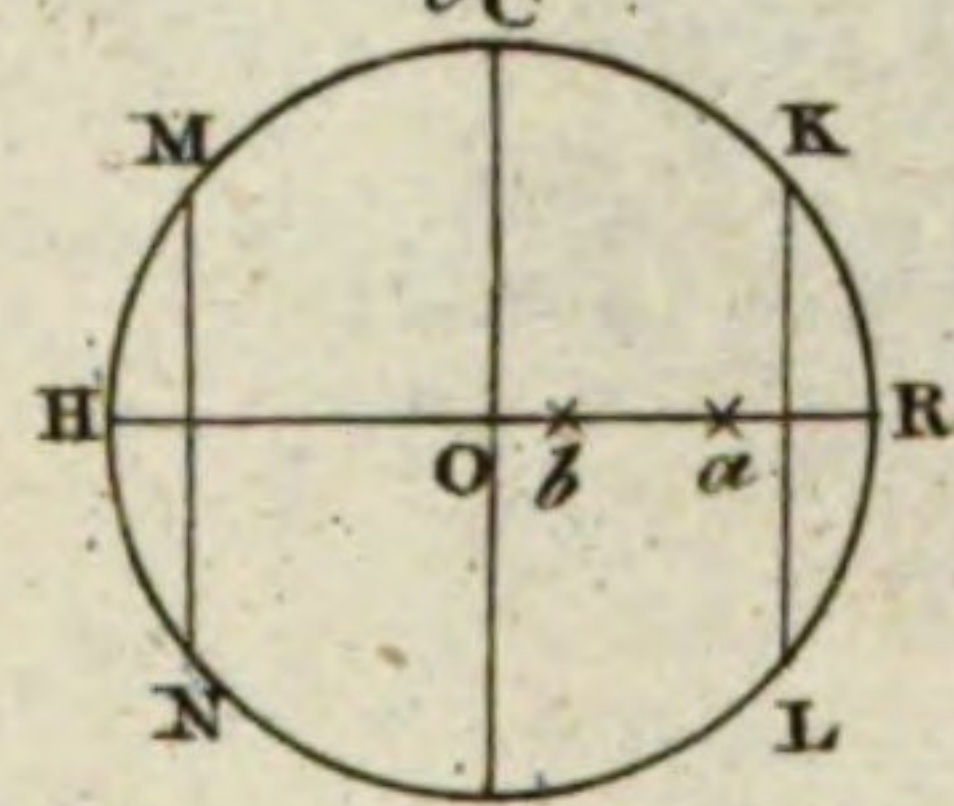


Fig. 5.

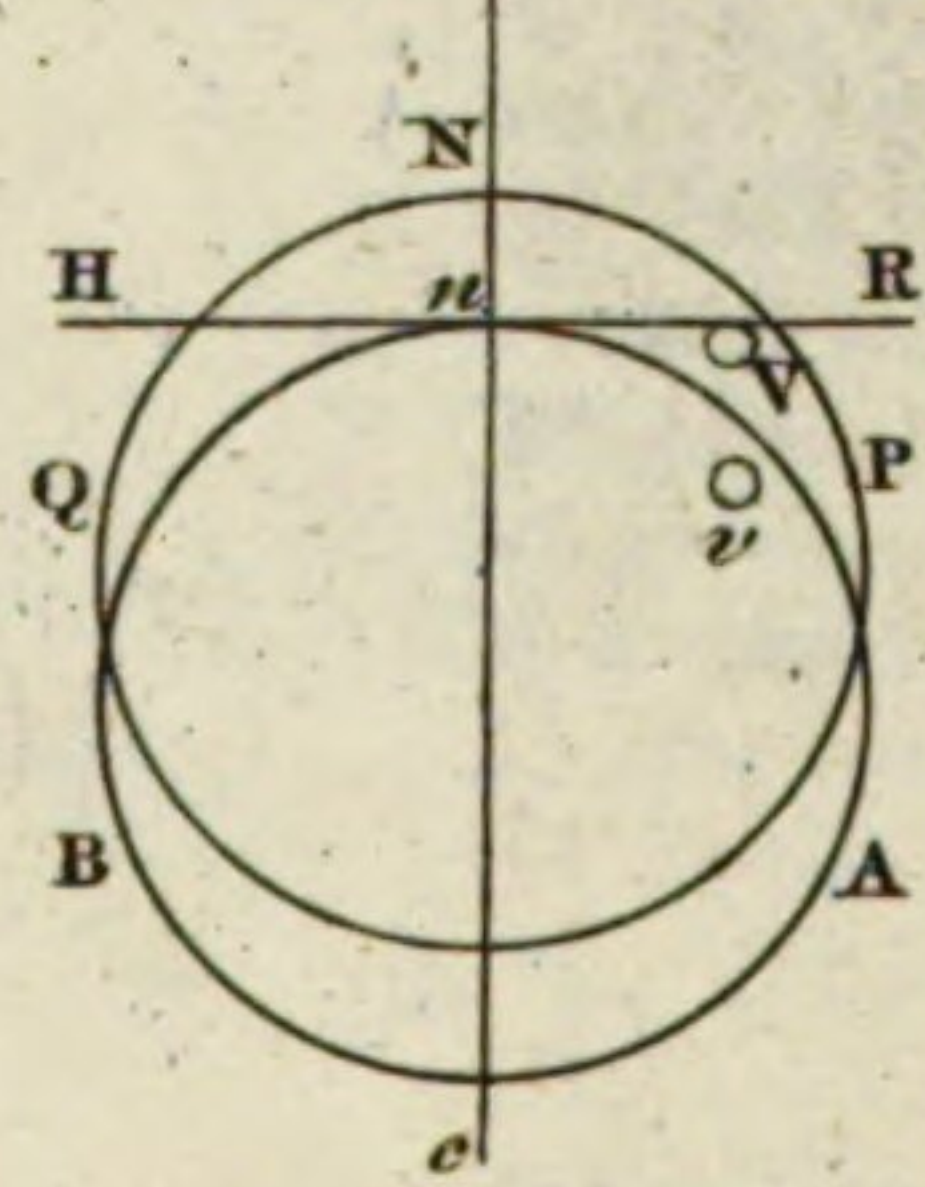


Fig. 6.

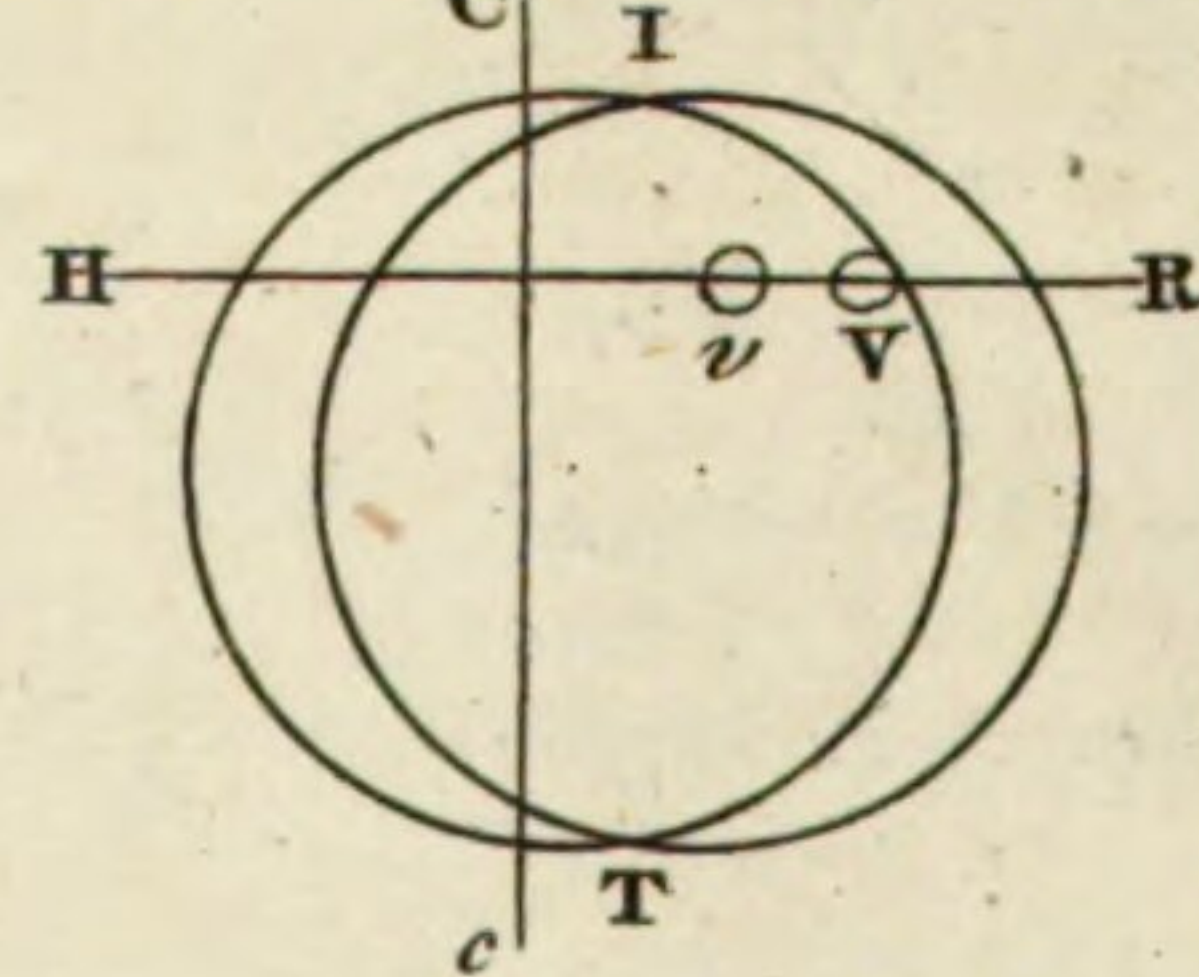


Fig. 10.

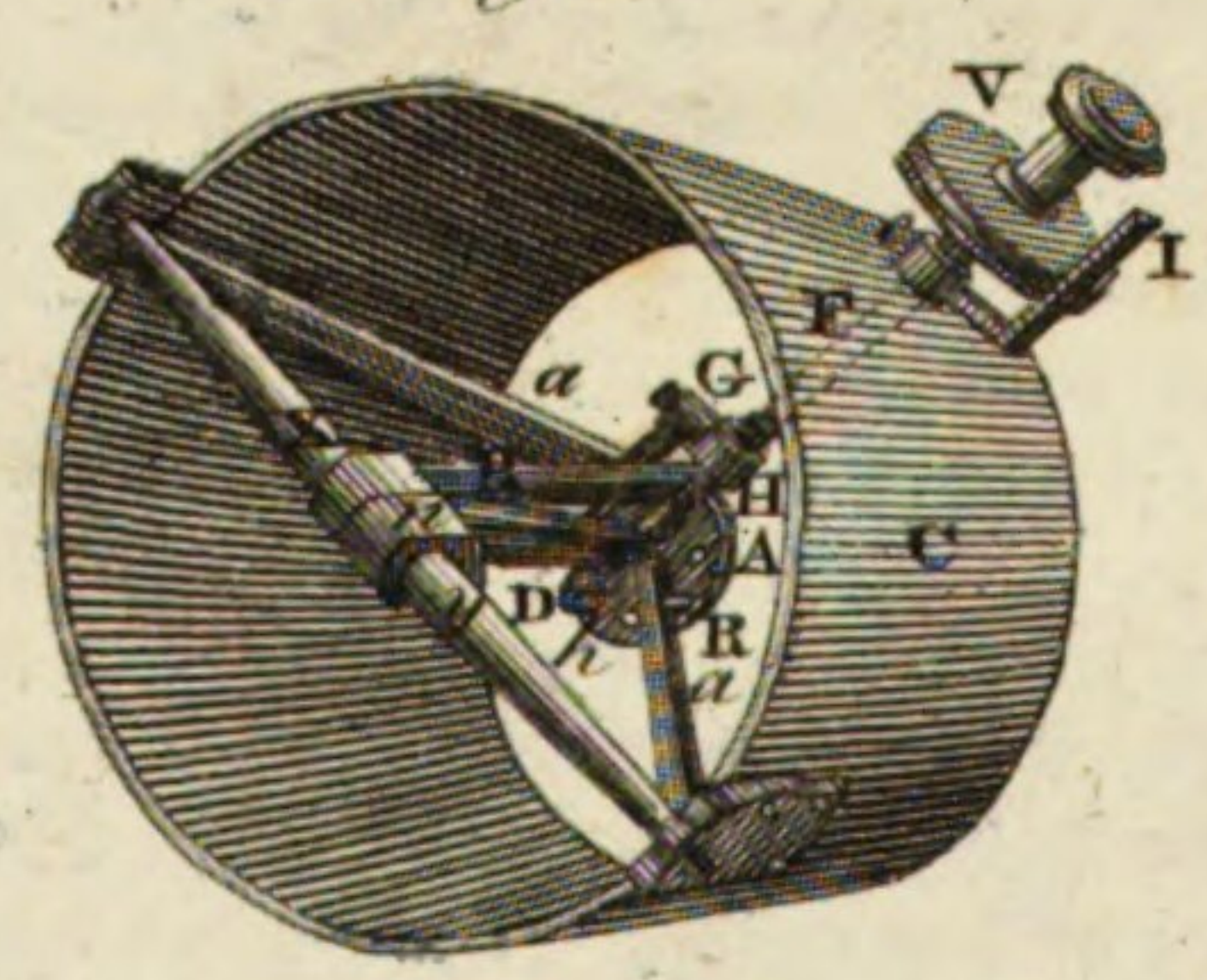


Fig. 2.

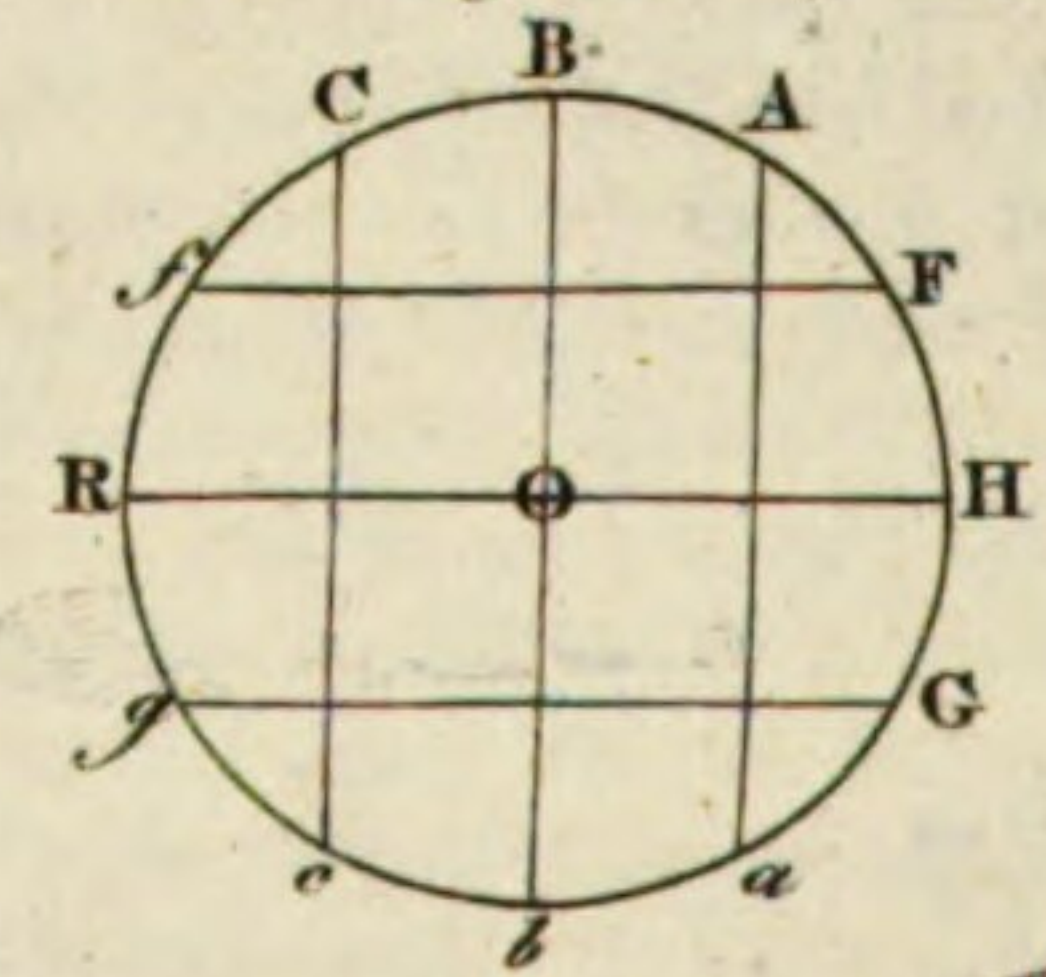


Fig. 7.

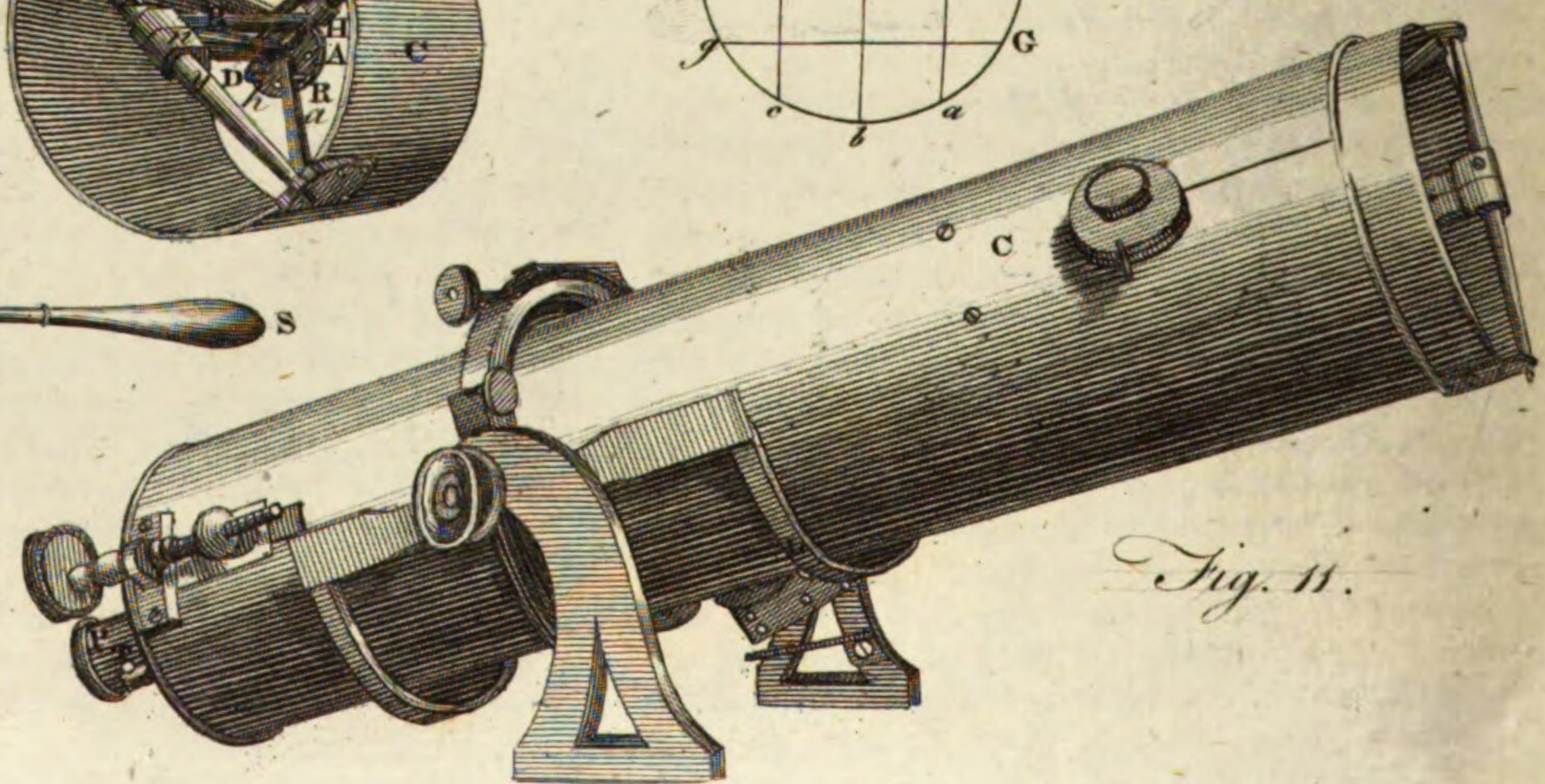
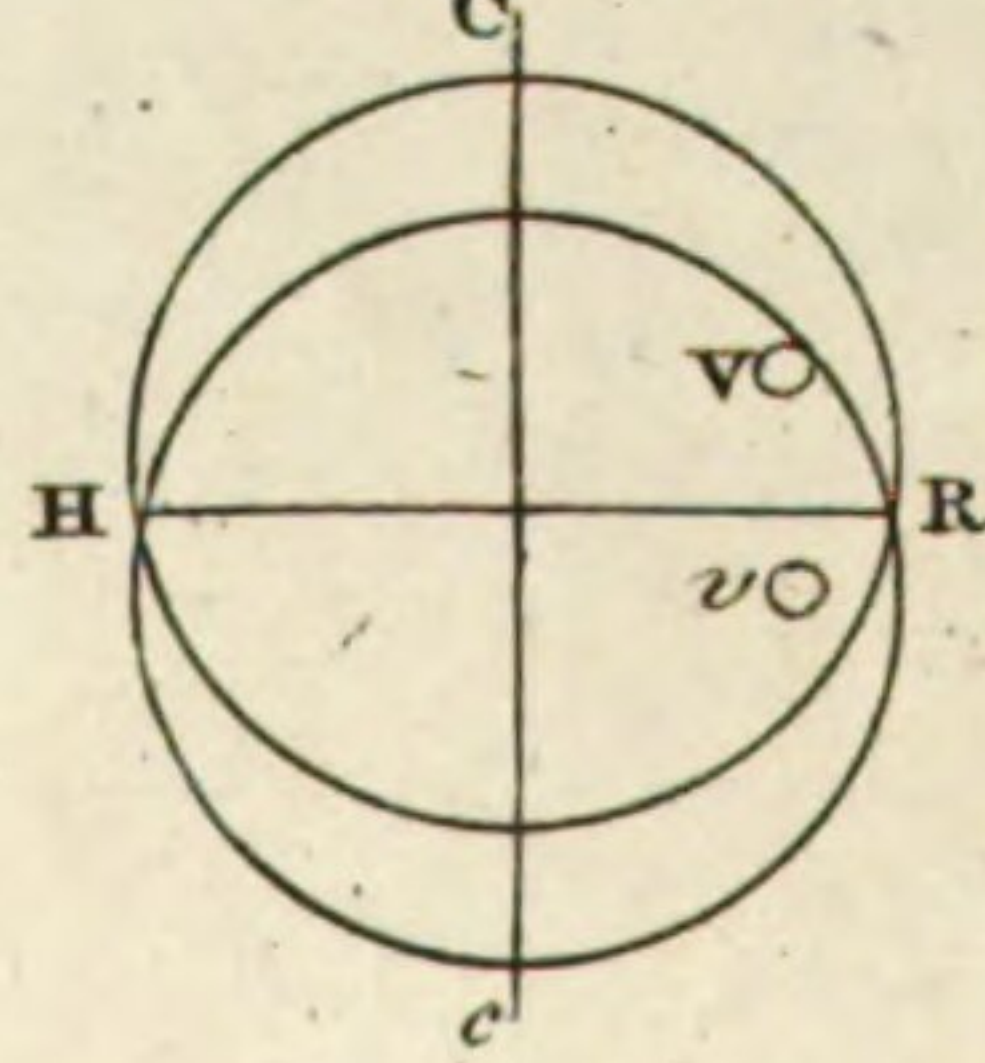


Fig. 11.

Mickle. Spencer," 4to; and in 1769 he published, "A Letter to Mr Harwood, wherein some of his evasive Glosses, false Translations, and blundering Criticisms, in support of the Arian Heresy, contained in his Literal Translation of the New Testament, are pointed out and confuted," 8vo: and next year he published "Mary Queen of Scots, an Elegy;" "Hengist and Mary, a Ballad;" and "Knowledge, an Ode;" in Pearch's Collection of Poems. In 1770 he published "Voltaire in the Shades, or Dialogues on the Deistical Controversy," 8vo. The Elegy on Mary had been submitted to the judgment of Lord Lyttelton, who declined to criticise it, not for its deficiency in poetical merit, but from thinking differently from the author concerning that unfortunate princess.

About this time Mr Mickle was a frequent writer in the Whitehall Evening Post; but a more important work now engaged his attention. When no more than 17 years of age he had read Castara's translation of the Lusiad of Camoens into French, and then projected the design of giving an English translation of it. From this, however, he was prevented by various avocations till the year 1771, when he published the first book as a specimen: and having prepared himself by acquiring some knowledge of the Portuguese language, he determined to apply himself entirely to this work. With this view he quitted his residence at Oxford, and went to a farm-house at Forest-hill, where he pursued his design with unremitting assiduity till the year 1775, when the work was entirely finished.

During the time that Mr Mickle was engaged in this work, he subsisted entirely by his employment as corrector of the press; and on his quitting that employment he had only the subscriptions he received for his translation to support him. Notwithstanding these difficulties, he adhered steadily to the plan he had laid down, and completed it in about five years.

When his work was finished, Mr Mickle applied to a person of great rank, with whom his family had been connected, for permission to dedicate it to him. Permission was granted, and his patron honoured him with a very polite letter; but after receiving a copy, for which an extraordinary price was paid for the binding, he did not think proper to take any notice of the author. At last a gentleman of high rank in the political world, a firm friend to the author, and who afterwards took him under his protection, waited on the patron, and heard him declare that he had not read the work, but that it had been represented not to have the merit it was at first said to possess. The applause with which the work was received, however, soon banished from the author's mind those disagreeable sensations which had been occasioned by the contemptuous neglect of his patron, as well as some severe criticisms which had been circulated concerning it. A second edition was prepared in 1778, with a plate prefixed to it, executed by the celebrated artist Mortimer; on whom Mr Mickle wrote an epitaph in 1779. This year also he published a pamphlet, intitled, "A Candid Examination of the Reasons for depriving the East India Company of its Charter, contained in The History and Management of the East India Company from its Commencement to the Present Time; together with some Strictures on the Self-Contradictions and

Historical Errors of Dr Adam Smith, in his Reasons for the Abolition of the said Company," 4to. About this time some of his friends thought of recommending him to the king as deserving of a pension; but this scheme was never put in execution. Dr Lowth, bishop of London, would have put him into orders, and provided for him in the church; but this was not agreeable to our author's disposition. While he was meditating a publication of all his poems, in which he would most probably have found his account, he was appointed secretary to Commodore Johnstone, who had lately obtained the command of the Romney man of war. In November 1779 he arrived at Lisbon, and was named by his patron joint agent for the prizes which were taken. In this capital and its neighbourhood he resided more than six months, being everywhere received with every mark of politeness and attention; and during this period he composed his poem called "Almada Hill," which in 1781 was published in quarto. He collected also many particulars concerning the manners of the Portuguese, which he intended also to have published. During his stay at Lisbon the royal academy was opened; and Mr Mickle, who was present at the ceremony of its commencement, had the honour to be admitted a member under the presidency of Don John of Braganza duke of Lafoens. His presence being thought necessary in England to attend to the proceedings of the courts of law respecting the condemnation of some of the prizes, he did not accompany the commodore in his last expedition, nor did he go any more to sea. In 1782 he published "The Prophecy of Queen Emma, an ancient Ballad lately discovered, written by Johannes Turgotus, prior of Durham, in the reign of William Rufus; to which is added by the Editor, an Account of the Discovery, and Hints towards a Vindication of the Authenticity, of the Poems of Ossian and Rowley," 8vo.

In June this year Mr Mickle married Miss Tomkins, daughter of the person with whom he resided at Forest-hill, while engaged in translating the Lusiad. Having received some fortune with this lady, as well as made some money himself when in the service of Commodore Johnstone, he now enjoyed a comfortable independence. Having fixed his residence at Wheatley in Oxfordshire, he devoted his time to the revision of his poetical works, which he proposed to publish by subscription; but the plan has not yet been carried into execution. The last seven years of his life were employed in writing for the European Magazine. The Fragments of Leo, and some of the most approved reviews of books, in that performance, were of his production. He died after a short illness on the 25th of October 1788 at Wheatley, leaving one son behind him. His poetry possesses much beauty, variety, harmony of numbers, and vigour of imagination: his life was without reproach; his foibles were few and in offensive; his virtues many; and his genius very considerable.

MICROCOSM, a Greek term signifying the *little world*; used by some for *man*, as being supposed an epitome of the universe or great world.

MICROCOSMIC ACID. See PHOSPHORUS (*Acid of*).

MICRO-

Mickle
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Microcosmic.

Microgra-
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Microme-
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MICROGRAPHY, the description of objects too minute to be viewed without the assistance of a microscope. See *MICROSCOPIC Objects*.

MICROMETER, an instrument, by the help of which the apparent magnitudes of objects viewed thro' telescopes or microscopes are measured with great exactness.

I. The first TELESCOPIC micrometers were only mechanical contrivances for measuring the image of an object in the focus of the object-glass. Before these contrivances were thought of, astronomers were accustomed to measure the field of view in each of their telescopes, by observing how much of the moon they could see through it, the semidiameter being reckoned at 15 or 16 minutes; and other distances were estimated by the eye, comparing them with the field of view. Mr Gascoigne, an English gentleman, however, fell upon a much more exact method, and had a Treatise on Optics prepared for the press; but he was killed during the civil wars in the service of Charles I. and his manuscript was never found. His instrument, however, fell into the hands of Mr R. Townly, who says, that by the help of it he could mark above 40,000 divisions in a foot.

Mr Gascoigne's instrument being shown to Dr Hooke, he gave a drawing and description of it, and proposed several improvements in it, which may be seen in Phil. Trans. abr. Vol. I. p. 217. Mr Gascoigne divided the image of an object, in the focus of the object-glass, by the approach of two pieces of metal ground to a very fine edge, in the place of which Dr Hooke would substitute two fine hairs stretched parallel to one another. Two other methods of Dr Hooke's, different from this, are described in his Posthumous Works, p. 497, 498. An account of several curious observations that Mr Gascoigne made by the help of his micrometer, particularly in the mensuration of the diameters of the moon and other planets, may be seen in the Phil. Trans. Vol. XLVIII. p. 195.

Mr Huygens, as appears by his System of Saturn, published in 1659, used to measure the apparent diameters of the planets, or any small angles, by first measuring the quantity of the field of view in his telescope; which, he says, is best done by observing the time which a star takes up in passing over it, and then preparing two or three long and slender brass plates, of various breadths, the sides of which were very straight, and converging to a small angle. In making use of these pieces of brass, he made them slide in two slits, that were made in the sides of the tube, opposite to the place of the image, and observed in what place it just covered the diameter of any planet, or any small distance that he wanted to measure. It was observed, however, by Sir Isaac Newton, that the diameters of planets, measured in this manner, will be larger than they should be, as all lucid objects appear to be when they are viewed upon dark ones.

In the Ephemerides of the Marquis of Malvasia, published in 1662, it appears that he had a method of measuring small distances between fixed stars and the diameters of the planets, and also of taking accurate draughts of the spots of the moon; and this was by a net of silver wire, fixed in the common focus of the object and eye-glass. He also contrived to make one of two stars to pass along the threads of this net, by turning it, or the telescope, as much as was necessary for

that purpose; and he counted, by a pendulum-clock, beating seconds, the time that elapsed in its passage from one wire to another, which gave him the number of the minutes and seconds of a degree contained between the intervals of the wires of his net, with respect to the focal length of his telescope.

In 1666, Messrs Azout and Picard published a description of a micrometer, which was nearly the same with that of the Marquis of Malvasia, excepting the method of dividing it, which they performed with more exactness by a screw. In some cases they used threads of silk, as being finer than silver wires. Dechales also recommends a micrometer consisting of fine wires, or filken threads, the distances of which were exactly known, disposed in the form of a net, as peculiarly convenient for taking a map of the moon.

M. de la Hire says, that there is no method more simple or commodious for observing the digits of an eclipse than a net in the focus of the telescope. These, he says, were generally made of filken threads; and that for this particular purpose six concentric circles had also been made use of, drawn upon oiled paper; but he advises to draw the circles on very thin pieces of glass with the point of a diamond. He also gives several particular directions to assist persons in the use of them. In another memoir he shows a method of making use of the same net for all eclipses, by using a telescope with two object-glasses, and placing them at different distances from one another.

Different Constructions of Micrometers. The first we shall describe is that by Mr Huygens. Let ABCD be a section of the telescope at the principal focus of the object-glass, or where the wires are situated, which are placed in a short tube containing the eye-glass, and may be turned into any position by turning that tube; *mn* is a fine wire extended over its centre; *vw*, *xy*, are two straight plates whose edges are parallel and well defined, and perpendicular to *mn*; *vw* is fixed, and *xy* moves parallel to it by means of a screw, which carries two indexes over a graduated plate, to show the number of revolutions and parts of a revolution which it makes. Now to measure any angle, we must first ascertain the number of revolutions and parts of a revolution corresponding to some known angle, which may be thus done: 1st, Bring the inner edges of the plates exactly to coincide, and set each index to 0; turn the screw, and separate the plates to any distance; and observe the time a star *m* is in passing along the wire *mn* from one plate to the other: for that time, turned into minutes and seconds of a degree, will be the angle answering to the number of revolutions, or the angle corresponding to the distance. Thus, if $d = \cos.$ of the star's declination, we have $15' dm$, the angle corresponding to this distance; and hence, by proportion, we find the angle answering to any other. 2^{dly}, Set up an object of a known diameter, or two objects at a given distance, and turn the screw till the edges of the plates become tangents to the object, or till their opening just takes in the distance of the two objects upon the wire *mn*; then from the diameter, or distance of the two objects from each other, and their distance from the glass, calculate the angle, and observe the number of revolutions and parts corresponding. 3^{dly}, Take the diameter of the sun on any day, by making the edges of the plates tangents to the opposite limbs, and find, from

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Plate
CCXCV.
fig. 1.

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from the nautical almanac, what is his diameter on that day. Here it will be best to take the upper and lower limbs of the sun when on the meridian, as he has then no motion perpendicular to the horizon. If the edges do not coincide when the indexes stand at 0, we must allow for the error. Instead of making a proportion, it is better to have a table calculated to show the angle corresponding to every revolution and parts of a revolution. But the observer must remember, that when the micrometer is fixed to telescopes of different focal lengths, a new table must be made. The whole system of wires is turned about in its own plane, by turning the eye-tube round with a hand, and by that means the wire *mn* can be thrown into any position, and consequently angles in any position may be measured. Dr Bradley added a small motion by a rack and pinion to set the wires more accurately in any position.

Instead of two plates, two wires were afterwards put; and Sir Isaac Newton observed, that the diameters of the planets measured by the plates were somewhat bigger than they ought, as appeared by comparing Mr Huygens's measures with others taken with the wires; and also by comparing the diameter of mercury observed in and out of the sun's disk, the latter being the greatest. Dark objects on bright ones appear less, and light objects on dark ones appear greater, than if they were equally bright; owing, perhaps, to the brighter image on the retina diffusing itself into the darker: and the bright image of the planet being intercepted by the plates, the faint diffused-light becomes more sensible, and is mistaken for the edge of the planet.

Fig. 2.

But the micrometer, as now contrived, is of use, not only to find the angular distance of bodies in the field of view at the same time, but also of those which, when the telescope is fixed, pass through the field of view successively; by which means we can find the difference of their right ascensions and declinations. Let *Aa*, *Bb*, *Cc*, be three parallel and equidistant wires, the middle one bisecting the field of view; *HOR* a fixed wire perpendicular to them passing through the centre of the field; and *Ff*, *Gg*, two wires parallel to it, each moveable by a micrometer screw, as before, so that they can be brought up to *HOR*, or a little beyond. Then to find the angular distance of two objects, bring them very near to *Bb*, and in a line parallel to it, by turning about the wires, and bring one upon *HOR*, and by the micrometer screw make *Ff* or *Gg* pass through the other; then turn the screw till that wire coincides with *HOR*, and the arc which the index has passed over shows their angular distance. If the objects be further remote than you can carry the distance of one of the wires *Ff*, *Gg*, from *HOR*, then bring one object to *Ff* and the other to *Gg*; and turn each micrometer screw till they meet, and the sum of the arcs passed over by each index gives their angular distance. If the objects be two stars, and one of them be made to run along *HOR*, or either of the moveable wires as occasion may require, the motion of the other will be parallel to these wires, and their difference of declinations may be observed with great exactness; but in taking any other distances, the motion

of the stars being oblique to them, it is not quite so easy to get them parallel to *Bb*; because if one star be brought near, and the eye be applied to the other to adjust the wires to it, the former star will have gotten a little away from the wire. Dr Bradley, in his account of the use of this micrometer, published by Dr Maskeleyne in the Philosophical Transactions for 1772, thinks the best way is to move the eye backwards and forwards as quick as possible; but it seems to me to be best to fix the eye at some point between, by which means it takes in both at once sufficiently well defined to compare them with *Bb*. In finding the difference of declinations, if both bodies do not come into the field of view at the same time, make one run along the wire *HOR*, as before, and fix the telescope and wait till the other comes in, and then adjust one of the moveable wires to it, and bring it up to *HOR*, and the index gives the difference of their declinations. The difference of time between the passage of the star at either of the cross moveable wires, and the transit of the other star over the cross fixed wire (which represents a meridian), turned into degrees and minutes, will give the difference of right ascension. The star has been here supposed to be bisected by the wire; but if the wire be a tangent to it, allowance must be made for the breadth of the wire, provided the adjustment be made for the coincidence of the wires. In observing the diameters of the sun, moon, or planets, it may perhaps be most convenient to make use of the outer edges of the wires, because they appear most distinct when quite within the limb: but if there should be any sensible inflection of the rays of light in passing by the wires, it will be best avoided by using the inner edge of one wire and the outward edge of the other; for by that means the inflection at both limbs will be the same way, and therefore there will be no alteration of the relative position of the rays passing by each wire. And it will be convenient in the micrometer to note at what division the index stands when the moveable wire coincides with *HOR*; for then you need not bring the wire when a star is upon it up to *HOR*, only reckon from the division at which the index then stands to the above division.

With a micrometer therefore thus adapted to a telescope, Mr Servington Savery of Exeter proposed a new way of measuring the difference between the greatest and least apparent diameters of the sun, although the whole of the sun was not visible in the field of view at once. The method we shall briefly describe. Place two object-glasses instead of one, so as to form two images whose limbs shall be at a small distance from each other; or instead of two perfect lenses, he proposed to cut a single lens into four parts of equal breadths by parallel lines, and to place the two segments with their straight sides against each other, or the two middle frustums with their opposite edges together; in either case, the two parts which before had a common centre and axis, have now their centres and axes separated, and consequently two images will be formed as before by two perfect lenses. Another method in reflectors was to cut the large concave reflector through the centre, and by a contrivance to turn up the outer edges whilst the straight ones remained

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mained fixed; by which means the axis of the two parts became inclined, and formed two images. Two images being formed in this manner, he proposed to measure the distance between the limbs when the diameters of the sun were the greatest and least, the difference of which would be the difference of the diameters required. Thus far we are indebted to Mr Savery for the idea of forming two images; and the admirable uses to which it was afterwards applied, we shall next proceed to describe.

The divided object-glass micrometer, as now made, was contrived by the late Mr John Dollond, and by him adapted to the object-end of a reflecting telescope, and has been since by the present Mr P. Dollond his son applied with equal advantage to the end of an achromatic telescope. The principle is this: The object-glass is divided into two segments in a line drawn through the centre; each segment is fixed in a separate frame of brass, which is moveable, so that the centres of the two segments may be brought together by a handle for that purpose, and thereby form one image of an object; but when separated they will form two images, lying in a line passing through the centre of each segment; and consequently the motion of each image will be parallel to that line, which can be thrown into any position by the contrivance of another handle to turn the glass about in its own plane. The brass-work carries a vernier to measure the distance of the centres of the two segments. Now let E and H be the centres of the two segments, F their principal focus, and P Q two distant objects in FE, FH, produced, or the opposite limbs of the same object PBQD; then the images of P and Q, formed by each segment, or the images of the opposite limbs of the object PBQD, coincide at F: hence two images $m \times F$, $n \times F$ of that object are formed, whose limbs are in contact; therefore the angular distance of the points P and Q is the same as the angle which the distance EH subtends at F, which, as the angles supposed to be measured are very small, will vary as EH extremely nearly; and consequently if the angle corresponding to one interval of the centres of the segments be known, the angle corresponding to any other will be found by proportion. Now to find the interval for some one angle,

N^o 218.

take the horizontal diameter of the sun on any day, by separating the images till the contrary limbs coincide, and read off by the vernier the interval of their centres, and look into the nautical almanac for the diameter of the sun on that day, and you have the corresponding angle. Or if greater exactness be required than from taking the angle in proportion to the distances of their centres, we may proceed thus:—Draw FG perpendicular to EH, which therefore bisects it; then one half EH, or EG, is the tangent of half the angle EFH; hence, half the distance of their centres: tangent of half the angle corresponding to that distance :: half any other distance of the centres: tangent of half the corresponding angle (λ).

Hence the method of measuring small angles is manifest; for we consider P, Q, either as two objects whose images are brought together by separating the two segments, or as the opposite limbs of one object PBQA, whose images, formed by the two segments E, H, touch at F: in the former case, EH gives the angular distance of the two objects; and in the latter, it gives the angle under which the diameter of the object appears. Hence, to find the angular distance of two objects, separate the segments till the two images which approach (B) each other coincide; and to find the diameter of an object, separate the segments till the contrary limbs of the images touch each other, and read off the distance of the centres of the segment from the vernier (C), and find the angle as directed in the last article. From hence appears one great superiority in this above the wire micrometer; as, with this, any diameter of an object may be measured with the same ease and accuracy; whereas with that we cannot with accuracy measure any diameter, except that which is at right angles to its apparent motion.

But, besides these two uses to which the instrument seems so well adapted, Dr Maskelyne has shown, in the Philosophical Transactions for the year 1771, how it may be applied to find the difference of right ascensions and declinations. For this purpose, two wires at right angles to each other, bisecting the field of view, must be placed in the principal focus of the eye-glass, and moveable about in their own plane.—

Let

(A) If the object be not a distant one, let f be the principal focus; then $Ff : FG :: FG : FK$ (FG being produced to meet a line joining the apparent places of the two objects P, Q), $\therefore$ dividendo, $fG : FG :: GK : FK$, and alternando, $fG : GK :: FG : FK ::$ (by similar triangles) $EH : PQ$, hence $\frac{EH}{fG} = \frac{PQ}{GK}$; therefore the angle subtended by EH at $f =$ the angle subtended by PQ at G; and consequently, as fG is constant, the angle measured at G is, in this case also, in proportion to EH. The instrument is not adapted to measure the angular distance of bodies, one of which is near and the other at a distance, because their images would not be formed together.

(B) Besides these two images, there will be two others receding from each other, for each segment gives an image of each object.

(C) To determine whether there be any error of adjustment of the micrometer scale, measure the diameter of any small well defined object, as Jupiter's equatorial diameter, or the longest axis of Saturn's ring, both ways, that is, with o on the vernier to the right and left of o on the scale, and half the difference is the error required; which must be added to or subtracted from all observations, according as the diameter measured with o on the vernier, when advanced on the scale, is less or greater than the diameter measured the other way. And it is also evident, that half the sum of the diameters thus measured gives the true diameter of the object.

Microm-
eter.

Fig. 4.

Let HCR be the field of view, HR and Cc the two wires; turn the wires till the westernmost star (which is the best, having further to move) run along ROH ; then separate the two segments and turn about the micrometer till the two images of the same star lie in the wire Cc ; and then, partly by separating the segments, and partly by raising or depressing the telescope, bring the two innermost images of the two stars to appear and run along ROH , as a, b , and the vernier will give the difference of their declinations; because, as the two images of one of the stars coincided with Cc , the image of each star was brought perpendicularly upon HR , or to HR in their proper meridian. And, for the same reason, the difference of their times of passing the wire COc will give their difference of right ascensions. These operations will be facilitated, if the telescope be mounted on a polar axis. If two other wires KL, MN , parallel to Cc , be placed near H and R , the observation may be made on two stars whose difference of meridians is nearly equal to HR the diameter of the field of view, by bringing the two images of one of the stars to coincide with one of these wires. If two stars be observed whose difference of declinations is well settled, the scale of the micrometer will be known.

It has hitherto been supposed, that the images of the two stars can be both brought into the field of view at once upon the wire HOR ; but if they cannot, set the micrometer to the difference of their declinations as nearly as you can, and make the image which comes first run along the wire HOR , by elevating or depressing the telescope; and when the other star comes in, if it do not also run along HOR , alter the micrometer till it does, and half the sum of the numbers shown by the micrometer at the two separate observations of the two stars on the wire HOR will be the difference of their declinations. That this should be true, it is manifestly necessary that the two segments should recede equally in opposite directions; and this is effected by Mr Dollond in his new improvement of the object-glass micrometer.

The difference of right ascensions and declinations of Venus or Mercury in the sun's disk and the sun's limb may be thus found. Turn the wires so that the north limb n of the sun's image AB , or the north limb of the image V of the planet, may run along the wire RH , which therefore will then be parallel to the equator, and consequently Cc a secondary to it; then separate the segments, and turn about the micrometer till the two images Vv of the planet pass Cc at the same time, and then by separating the segments, bring the north limb of the northernmost image V of the planet to touch HR , at the time the northernmost limb n of the southernmost image AB of the sun touches it, and the micrometer shows the difference of declinations of the northernmost limbs of the planet and sun, for the reason formerly given †, we having brought the northernmost limbs of the two innermost images V and AB to HR , these two being manifestly interior to v and the northernmost limb N of the image PQ . In the same manner we take the difference of declinations of their southernmost limbs; and

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half the difference of the two measures, (taking immediately one after another) is equal to the difference of the declinations of their centres, without any regard to the sun's or planet's diameters, or error of adjustment of the micrometer; for as it affects both equally, the difference is the same as if there were no error: and the difference of the times of the transits of the eastern or western limbs of the sun and planet over Cc gives the difference of their right ascensions.

Instead of the difference of right ascensions, the distance of the planet from the sun's limb, in lines parallel to the equator, may be more accurately observed thus: Separate the segments, and turn about the wires and micrometer, so as to make both images V, v , run along HR , or so that the two intersections I, T , of the sun's image may pass Cc at the same time. Then bring the planet's and sun's limbs into contact, as at V , and do the same for the other limb of the sun, and half the difference gives the distance of the centre of the planet from the middle of the chord on the sun's disk parallel to the equator, or the difference of the right ascensions of their centres, allowing for the motion of the planet in the interval of the observations, without any regard to the error of adjustment, for the same reason as before. For if you take any point in the chord of a circle, half the difference of the two segments is manifestly the distance of the point from the middle of the chord; and as the planet runs along HR , the chord is parallel to the equator.

In like manner, the distances of their limbs may be measured in lines perpendicular to the equator, by bringing the micrometer into the position already described*, and instead of bringing V to HR , separate the segments till the northernmost limbs coincide as at V ; and in the same manner make their southernmost images to coincide, and half the difference of the two measures, allowing for the planet's motion, gives the difference of the declinations of their centres.

Hence the true place of a planet in the sun's disk may at any time of its transit be found; and consequently the nearest approach to the centre and the time of ecliptic conjunction may be deduced, although the middle should not be observed.

But however valuable the object-glass micrometer undoubtedly is, difficulties sometimes have been found in its use, owing to the alteration of the focus of the eye, which will cause it to give different measures of the same angle at different times. For instance, in measuring the sun's diameter, the axis of the pencil coming through the two segments from the contrary limbs of the sun, as PF, QF , fig. 3. crossing one another in the focus F under an angle equal to the sun's semidiameter, the union of the limbs cannot appear perfect, unless the eye be disposed to see objects distinctly at the place where the images are formed; for if the eye be disposed to see objects nearer to or further off than that place, in the latter case the limbs will appear separated, and in the former they will appear to lap over (ν). This imperfection led Dr Ma-

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(ν) For if the eye can see distinctly an image at F , the pencils of rays, of which PF, QF are the two axes, diverging from F , are each brought to a focus on the retina at the same point; and therefore the two limbs appear

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Fig. 6.

* See the
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Maskelyne to inquire, whether some method might not be found of producing two distinct images of the sun, or any other object, by bringing the axis of each pencil to coincide, or very nearly so, before the formation of the images, by which means the limbs when brought together would not be liable to appear separated from any alteration of the eye; and this he found would be effected by the refraction of two prisms, placed either without or within the telescope; and on this principle, placing the prisms within, he constructed a new micrometer, and had one executed by Mr Dollond, which upon trial answered as he expected. The construction is as follows.

Fig. 8, 9.

Let AB be the object-glass; ab the image, suppose of the sun, which would have been formed in the principal focus Q ; but let the prisms PR , SR be placed to intercept the rays, and let EF , WG , be two rays proceeding from the eastern and western limbs of the sun, converging, after refraction at the lens, to a and b ; and suppose the refraction of the prisms to be such, that in fig. 8. the ray EFR , after refraction at R by the prism PR , may proceed in the direction RQ ; and as all the rays which were proceeding to a suffer the same refraction at the prism, they will all be refracted to Q ; and therefore, instead of an image ab , which would have been formed by the lens alone, an image Qc is formed by those rays which fall on the prism PR ; and for the same reason, the rays falling on the prism SR will form an image Qd : and in fig. 9. the image of the point b is brought to Q , by the prism PR , and consequently an image Qd is formed by those rays which fall on PR : and for the same reason, an image Qc is formed by the rays falling on SR . Now in both cases, as the rays EFR , WGR , coming from the two opposite limbs of the sun, and forming the point of contact of the two limbs, proceed in the same direction RQ , they must thus accompany each other through the eye-glass and also through the eye, whatever refractive power it has, and therefore to every eye the images must appear to touch. Now the angle aRb is twice the refraction of the prism, and the angle aCb is the diameter of the sun; and as these angles are very small, and have the same subtense ab , we have the angle aRb : angle aCb :: CQ : RQ . — Now as CQ is constant, and also the angle aRb , being twice the refraction of the prism, the angle aCb varies as RQ . Hence the extent of the scale for measuring angles becomes the focal length of the object glass, and the angle measured is in proportion to the distance of the prisms from the principal focus of the object glass; and the micrometer can measure all angles (very small ones excepted, for the reason afterwards given*) which do not exceed the sum of the refractions of the prisms; for the angle aCb , the diameter of the object to be measured, is always less than the angle aRb , the sum of the refractions of the prisms, except when the prisms touch the object glass, and then they become equal. The scale can never be out of adjustment, as the point o , where the measurement begins, answers to the focus of the object glass, which is a fixed point for all distant objects, and we have only to find the

value of the scale answering to some known angle: for instance, bring the two limbs of the sun's images into contact, and measure the distance of the prisms from the focus, and look in the nautical almanac for the sun's diameter, and you get the value of the scale.

In fig. 8. the limb Q , of the image Qc , is illuminated by the rays falling on the object glass between A and F , and of the image Qd by those falling between B and G ; but in fig. 9. the same limbs are illuminated by the rays falling between B and F , A and G respectively, and therefore will be more illuminated than in the other case; but the difference is not considerable in achromatic telescopes, on account of the great aperture of the object-glass compared with the distance FG .

It might be convenient to have two sets of prisms, one for measuring angles not exceeding $36'$, and therefore fit for measuring the diameters of the sun and moon, and the lucid parts and distances of the cusps in their eclipses; and another for measuring angles not much greater than $1'$, for the convenience of measuring the diameters of the planets. For as QC : QR :: sum of the refractions of the prisms : angle aCb , the apparent diameter of the object, it is evident that if you diminish the third term, you must increase the second in the same ratio, in order to measure the same angle; and thus by diminishing the refractive angle of the prisms, you throw them further from Q , and consequently avoid the inconvenience of bringing them near to Q , for the reason in the next paragraph; and at the same time you will increase the illumination in a small degree. The prisms must be achromatic, each composed of two prisms of flint and crown glass, placed with their refracting angles contrariways, otherwise the images will be coloured.

In the construction here described, the angle measured becomes evanescent when the prisms come to the principal focus of the object glass, and therefore o on the scale then begins: but if the prisms be placed in the principal focus they can have no effect, because the pencil of rays at the junction of the prisms would then vanish, and therefore it is not practicable to bring the two images together to get o on the scale. Dr Maskelyne, therefore, thought of placing another pair of prisms within, to refract the rays before they came to the other prisms, by which means the two images would be formed into one before they came to the principal focus, and therefore o on the scale could be determined. But to avoid the error arising from the multiplication of mediums, he, instead of adding another pair of prisms, divided the object glass through its centre, and sliding the segments a little it separated the images, and then by the prisms he could form one image very distinctly, and consequently could determine o on the scale; for by separating the two segments you form two images, and you will separate the two pencils so that you may move up the two prisms, and the two pencils will fall on each respectively, and the two images may be formed into one. In the instrument which Dr Maskelyne had made, o on the scale was chosen to be about $\frac{2}{3}$ of the focal length of the object-glass,

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appear to coincide: but if we increase the refractive power of the eye, then each pencil is brought to a focus, and they cross each other before the rays come to the retina, consequently the two limbs on the retina will lap over; and if we diminish the refractive power of the eye, then each pencil being brought to a focus beyond the retina, and not crossing till after they have passed it, the two limbs on the retina must be separated.

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glass, and each prism refracted $27'$. By this means all angles are measured down to 0.

In the Philosophical Transactions for 1779, Mr Ramsden has described two new micrometers, which he contrived with a view of remedying the defects of the object-glass micrometer.

1. One of these is a *catoptric* micrometer, which, beside the advantage it derives from the principle of reflection, of not being disturbed by the heterogeneity of light, avoids every defect of other micrometers, and can have no aberration, nor any defect arising from the imperfection of materials or of execution; as the extreme simplicity of its construction requires no additional mirrors or glasses to those required for the telescope; and the separation of the image being effected by the inclination of the two specula, and not depending on the focus of any lens or mirror, any alteration in the eye of an observer cannot affect the angle measured. It has peculiar to itself the advantages of an adjustment, to make the images coincide in a direction perpendicular to that of their motion; and also of measuring the diameter of a planet on both sides of the zero, which will appear no inconsiderable advantage to observers who know how much easier it is to ascertain the contact of the external edges of two images than their perfect coincidence.

Fig. 10.

A represents the small speculum divided into two equal parts; one of which is fixed on the end of the arm B; the other end of the arm is fixed on a steel axis X, which crosses the end of the telescope C. The other half of the mirror A is fixed on the arm D, which arm at the other end terminates in a socket y, that turns on the axis X; both arms are prevented from bending by the braces *a a*. G represents a double screw, having one part *e* cut into double the number of threads in an inch to that of the part *g*: the part *e* having 100 threads in one inch, and the part *g* 50 only. The screw *e* works in a nut F in the side of the telescope, while the part *g* turns in a nut H, which is attached to the arm B; the ends of the arms B and D, to which the mirrors are fixed, are separated from each other by the point of the double screw pressing against the stud *b*, fixed to the arm D, and turning in the nut H on the arm B. The two arms B and D are pressed against the direction of the double screw *g* by a spiral spring within the part *n*, by which means all shake or play in the nut H, on which the measure depends, is entirely prevented.

From the difference of the threads on the screw at *e* and *g*, it is evident, that the progressive motion of the screw through the nut will be half the distance of the separation of the two halves of the mirror; and consequently the half mirrors will be moved equally in contrary directions from the axis of the telescope C.

The wheel V fixed on the end of the double screw has its circumference divided into 100 equal parts, and numbered at every fifth division with 5, 10, &c. to 100, and the index I shows the motion of the screw with the wheel round its axis, while the number of revolutions of the screw is shown by the divisions on the same index. The steel screw at R may be turned by the key S, and serves to incline the small mirror at right angles to the direction of its motion. By turning the finger-head T (fig. 11.), the eye-tube P is

brought nearer or farther from the small mirror, to adjust the telescope to distinct vision; and the telescope itself hath a motion round its axis for the convenience of measuring the diameter of a planet in any direction. The inclination of the diameter measured with the horizon is shown in degrees and minutes by a level and vernier on a graduated circle, at the breech of the telescope.

"It is necessary to observe (says Mr Ramsden), that, besides the table for reducing the revolutions and parts of the screw to minutes, seconds, &c. it may require a table for correcting a very small error which arises from the excentric motion of the half-mirrors. By this motion their centres of curvature will (when the angle to be measured is large) approach a little towards the large mirror: the equation for this purpose in small angles is insensible; but when angles to be measured exceed ten minutes, it should not be neglected. Or, the angle measured may be corrected by diminishing it in the proportion the versed sine of the angle measured, supposing the eccentricity radius, bears to the focal length of the small mirror."

Mr Ramsden preferred Cassegrain's construction of the reflecting telescope to either the Gregorian or Newtonian; because in the former, errors caused by one speculum are diminished by those in the other. From a property of the reflecting telescope (which, he observes, has not been attended to), that the apertures of the two specula are to each other very nearly in the proportion of their focal lengths, it follows, that their aberrations will be to each other in the same proportion; and these aberrations are in the same direction, if the two specula are both concave; or in contrary directions, if one speculum is concave and the other convex. In the Gregorian construction, both specula being concave, the aberration at the second image will be the sum of the aberrations of the two mirrors; but in the Cassegrain construction, one mirror being concave and the other convex, the aberration at the second image will be the difference between their aberrations. By assuming such proportions for the *foci* of the specula as are generally used in the reflecting telescope, which is about as 1 to 4, the aberration in the Cassegrain construction will be to that in the Gregorian as 3 to 5.

2. The other is a *dioptric* micrometer, or one suited to the principle of refraction. This micrometer is applied to the erect eye-tube of a refracting telescope, and is placed in the conjugate focus of the first eye-glasses: in which position, the image being considerably magnified before it comes to the micrometer, any imperfection in its glass will be magnified only by the remaining eye-glasses, which in any telescope seldom exceeds five or six times. By this position also the size of the micrometer glass will not be the $\frac{1}{100}$ part of the area which would be required if it was placed in the object-glass; and, notwithstanding this great disproportion of size, which is of great moment to the practical optician, the same extent of scale is preserved, and the images are uniformly bright in every part of the field of the telescope.

Fig. 12. represents the glasses of a refracting telescope; *xy*, the principal pencil of rays from the object-glass O; *tt* and *uu*, the axis of two oblique pencils; *a*, the first eye-glass; *m*, its conjugate focus, or the

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place of the micrometer; b the second eye-glass; c the third; and d the fourth, or that which is nearest the eye. Let p be the diameter of the object-glass, e the diameter of a pencil at m , and f the diameter of the pencil at the eye; it is evident, that the axis of the pencils from every part of the image will cross each other at the point m ; and e , the width of the micrometer-glass, is to p the diameter of the object-glass as $m a$ is to $g o$, which is the proportion of the magnifying power at the point m ; and the error caused by an imperfection in the micrometer-glass placed at m will be to the error, had the micrometer been at O , as m is to p .

Fig. 13. represents the micrometer; A , a convex or concave lens divided into two equal parts by a plane across its centre; one of these semi-lenses is fixed in a frame B , and the other in the frame E ; which two frames slide on a plate H , and are pressed against it by thin plates $a a$: the frames B and E are moved in contrary directions by turning the button D ; L is a scale of equal parts on the frame B ; it is numbered from each end towards the middle with 10, 20, &c. There are two verniers on the frame E , one at M and the other at N , for the convenience of measuring the diameter of a planet, &c. on both sides the zero. The first division on both these verniers coincides at the same time with the two zeros on the scale L ; and, if the frame is moved towards the right, the relative motion of the two frames is shown on the scale L by the vernier M ; but if the frame B be moved towards the left, the relative motion is shown by the vernier N .—This micrometer has a motion round the axis of vision, for the convenience of measuring the diameter of a planet, &c. in any direction, by turning an endless screw F ; and the inclination of the diameter measured with the horizon is shown on the circle g by a vernier on the plate V . The telescope may be adjusted to distinct vision by means of an adjusting screw, which moves the whole eye-tube with the micrometer nearer or farther from the object-glass, as telescopes are generally made; or the same effect may be produced in a better manner, without moving the micrometer, by sliding the part of the eye tube m on the part n , by help of a screw or pinion. The micrometer is made to take off occasionally from the eye tube, that the telescope may be used without it.

Still, however, micrometers remained in several respects imperfect. In particular, the imperfections of the parallel-wire micrometer in taking the distance of very close double stars, are the following.

When two stars are taken between the parallels, the diameters must be included. Mr Herschel informs us, he has in vain attempted to find lines sufficiently thin to extend them across the centres of the stars so that their thickness might be neglected. The single threads of the silk-worm, with such lenses as he uses, are so much magnified that their diameter is more than that of many of the stars. Besides, if they were much less than they are, the power of deflection of light would make the attempt to measure the distance of the centres this way fruitless: for he has always found the light of the stars to play upon those lines and separate their apparent diameters into two parts. Now since the spurious diameters of the stars thus included, as Mr. Herschel assures us, are continually changing according to the state of the air,

and the length of time we look at them, we are, in some respect, left at an uncertainty, and our measures taken at different times and with different degrees of attention, will vary on that account. Nor can we come at the true distance of the centres of any two stars, one from another, unless we could tell what to allow for the semidiameters of the stars themselves; for different stars have different apparent diameters, which, with a power of 227, may differ from each other as far as two seconds.

The next imperfection is that which arises from a deflection of light upon the wires when they approach very near to each other; for if this be owing to a power of repulsion lodged at the surface, it is easy to understand, that such powers must interfere with each other, and give the measures larger in proportion than they would have been if the repulsive power of one wire had not been opposed by a contrary power of the other wire.

Another very considerable imperfection of these micrometers is a continual uncertainty of the real zero. Mr Herschel has found, that the least alteration in the situation and quantity of light will affect the zero, and that a change in the position of the wires, when the light and other circumstances remain unaltered, will also produce a difference. To obviate this difficulty, whenever he took a measure that required the utmost accuracy, his zero was always taken immediately after, while the apparatus remained in the same situation it was in when the measure was taken; but this enhances the difficulty, because it introduces an additional observation.

The next imperfection, which is none of the smallest, is that every micrometer that has hitherto been in use requires either a screw, or a divided bar and pinion, to measure the distance of the wires or divided image. Those who are acquainted with works of this kind are but too sensible how difficult it is to have screws that shall be perfectly equal in every thread or revolution of each thread; or pinions and bars that shall be so evenly divided as perfectly to be depended upon in every leaf and tooth to perhaps the two, three, or four thousandth part of an inch: and yet, on account of the small scale of those micrometers, these quantities are of the greatest consequence; an error of a single thousandth part inducing in most instruments a mistake of several seconds.

The last and greatest imperfection of all is, that these wire micrometers require a pretty strong light in the field of view; and when Mr Herschel had double stars to measure, one of which was very obscure, he was obliged to be content with less light than is necessary to make the wires perfectly distinct; and several stars on this account could not be measured at all, though otherwise not too close for the micrometer.

Mr Herschel, therefore, having long had much occasion for micrometers that would measure exceeding small distances exactly, was led to bend his attention to the improvement of these instruments; and the result of his endeavours has been a very ingenious instrument called a *lamp-micrometer*, which is not only free from the imperfections above specified, but also possesses the advantages of a very large scale. This instrument is described in the Philosophical Transactions for 1782; and the construction of it is as follows:

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ABGCFE (fig. 14.) is a stand nine feet high, upon which a semicircular board *ghogp* is moveable upwards or downwards, in the manner of some fire-screens, as occasion may require, and is held in its situation by a peg *p* put into any one of the holes of the upright piece AB. This board is a segment of a circle of fourteen inches radius, and is about three inches broader than a semicircle, to give room for the handles *rD*, *eP*, to work. The use of this board is to carry an arm L, thirty inches long, which is made to move upon a pivot at the centre of the circle, by means of a string, which passes in a groove upon the edge of the semicircle *pgobq*; the string is fastened to a hook at *o* (not expressed in the figure, being at the back of the arm L, and passing along the groove from *ob* to *q* is turned over a pulley at *q*, and goes down to a small barrel *e*, within the plane of the circular board, where a double-jointed handle *eP* commands its motion. By this contrivance, we see, the arm L may be lifted up to any altitude from the horizontal position to the perpendicular, or be suffered to descend by its own weight below the horizontal to the reverse perpendicular situation. The weight of the handle P is sufficient to keep the arm in any given position; but if the motion should be too easy, a friction spring applied to the barrel will moderate it at pleasure.

In front of the arm L a small slider, about three inches long, is moveable in a rabbet from the end L towards the centre backwards and forwards. A string is fastened to the left side of the little slider, and goes towards L, where it passes round a pulley at *m*, and returns under the arm from *m*, *n*, towards the centre, where it is led in a groove on the edge of the arm, which is of a circular form, upwards to a barrel (raised above the plane of the circular board) at *r*, to which the handle *rD* is fastened. A second string is fastened to the slider, at the right side, and goes towards the centre, where it passes over a pulley *n*; and the weight *w*, which is suspended by the end of this string, returns the slider towards the centre, when a contrary turn of the handle permits it to act.

By *a* and *b* are represented two small lamps, two inches high, $1\frac{1}{2}$ in breadth by $1\frac{1}{4}$ in depth. The sides, back, and top, are made so as to permit no light to be seen, and the front consists of a thin brass sliding door. The flame in the lamp *a* is placed three-tenths of an inch from the left side, three-tenths from the front, and half an inch from the bottom. In the lamp *b* it is placed at the same height and distance, measuring from the right side. The wick of the flame consists only of a single very thin lamp cotton-thread; for the smallest flame being sufficient, it is easier to keep it burning in so confined a place. In the top of each lamp must be a little slit lengthways, and also a small opening in one side near the upper part, to permit air enough to circulate to feed the flame. To prevent every reflection of light, the side opening of the lamp *a* should be to the right, and that of the lamp *b* to the left. In the sliding door of each lamp is made a small hole with the point of a very fine needle just opposite the place where the wicks are burning, so that when the sliders are shut down, and every thing dark, nothing shall be seen but two fine lucid points of the size of two stars of the third or fourth magnitude. The lamp *a* is placed so that its lucid point may be in the centre of

the circular board where it remains fixed. The lamp *b* is hung to the little slider which moves in the rabbet of the arm, so that its lucid point, in an horizontal position of the arm, may be on a level with the lucid point in the centre. The moveable lamp is suspended upon a piece of brass fastened to the slider by a pin exactly behind the flame, upon which it moves as a pivot. The lamp is balanced at the bottom by a leaden weight, so as always to remain upright, when the arm is either lifted above or depressed below the horizontal position. The double-jointed handles *rD*, *eP*, consist of light deal rods, ten feet long, and the lowest of them may have divisions, marked upon it near the end P, expressing exactly the distance from the central lucid point in feet, inches, and tenths.

From this construction we see, that a person at a distance of ten feet may govern the two lucid points, so as to bring them into any required position south or north preceding or following from 0 to 90° by using the handle P, and also to any distance from six-tenths of an inch to five or six and twenty inches by means of the handle D. If any reflection or appearance of light should be left from the top or sides of the lamps, a temporary screen, consisting of a long piece of paste-board, or a wire frame covered with black cloth, of the length of the whole arm, and of any required breadth, with a slit of half an inch broad in the middle, may be affixed to the arm by four bent wires projecting an inch or two before the lamps, situated so that the moveable lucid point may pass along the opening left for that purpose.

Fig. 15. represents part of the arm L, half the real size; S the slider; *m* the pulley, over which the cord *xtyz* is returned towards the centre; *v* the other cord going to the pulley *n* of fig. 14. R the brass piece moveable upon the pin *c*, to keep the lamp upright. At R is a wire rivetted to the brass piece, upon which is held the lamp by a nut and screw. Fig. 16. 17. represent the lamps *a*, *b*, with the sliding doors open, to show the situation of the wicks. W is the leaden weight with a hole *d* in it, through which the wire R of fig. 15. is to be passed when the lamp is to be fastened to the slider S. Fig. 18. represents the lamp *a* with the sliding door shut; *l* the lucid point; and *ik* the openings at the top, and *s* at the sides, for the admission of air.

“Every ingenious artist (says Mr Herschel) will soon perceive, that the motions of this micrometer are capable of great improvement by the application of wheels and pinions, and other well known mechanical resources; but as the principal object is only to be able to adjust the two lucid points to the required position and distance, and to keep them there for a few minutes, while the observer goes to measure their distance, it will not be necessary to say more upon the subject.

“I am now to show the application of this instrument. It is well known to opticians and others who have been in the habit of using optical instruments, that we can with one eye look into a microscope or telescope, and see an object much magnified, while the naked eye may see a scale upon which the magnified picture is thrown. In this manner I have generally determined the power of my telescopes; and any one who has acquired a facility of taking such observations will

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will very seldom mistake so much as one in fifty in determining the power of an instrument, and that degree of exactness is fully sufficient for the purpose.

"The Newtonian form is admirably adapted to the use of this micrometer; for the observer stands always erect, and looks in a horizontal direction, notwithstanding the telescope should be elevated to the zenith. Besides, his face being turned away from the object to which his telescope is directed, this micrometer may be placed very conveniently without causing the least obstruction to the view: therefore, when I use this instrument, I put it at ten feet distance from the left eye, in a line perpendicular to the tube of the telescope, and raise the moveable board to such a height that the lucid point of the central lamp may be upon a level with the eye. The handles, lifted up, are passed through two loops fastened to the tube, just by the observer, so as to be ready for his use. I should observe, that the end of the tube is cut away, so as to leave the left eye entirely free to see the whole micrometer.

"Having now directed the telescope to a double star, I view it with the right eye, and at the same time with the left see it projected upon the micrometer: then, by the handle P, which commands the position of the arm, I raise or depress it so as to bring the two lucid points to a similar situation with the two stars; and, by the handle D, I approach or remove the moveable lucid point to the same distance of the two stars, so that the two lucid points may be exactly covered by or coincide with the stars. A little practice in this business soon makes it easy, especially to one who has already been used to look with both eyes open.

"What remains to be done is very simple. With a proper rule, divided into inches and fortieth parts, I take the distance of the lucid points, which may be done to the greatest nicety, because, as I observed before, the little holes are made with the point of a very fine needle. The measure thus obtained is the tangent of the magnified angle under which the stars are seen to a radius of ten feet; therefore, the angle being found and divided by the power of the telescope gives the real angular distance of the centres of a double star.

"For instance, September 25, 1781, I measured α Herculis with this instrument. Having caused the two lucid points to coincide exactly with the stars centre upon centre, I found the radius or distance of the central lamp from the eye 10 feet 4.15 inches; the tangent or distance of the two lucid points 50.6 fortieth parts of an inch; this gives the magnified angle 35', and dividing by the power 460, which I used, we obtain $4'' 34'''$ for the distance of the centres of the two stars. The scale of the micrometer at this very convenient distance, with the power of 460 (which my telescope bears so well upon the fixed stars that for near a twelvemonth past I have hardly used any other), is above a quarter of an inch to a second; and by putting on my power of 932, which in very fine evenings is extremely distinct, I obtain a scale of more than half an inch to a second, without increasing the distance of the micrometer; whereas the most perfect of my former micrometers, with the same instrument, had a scale of less than the two thousandth part of an inch to a second.

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"The measures of this micrometer are not confined to double stars only, but may be applied to any other objects that require the utmost accuracy, such as the diameters of the planets or their satellites, the mountains of the moon, the diameters of the fixed stars, &c.

"For instance, October 22. 1781, I measured the apparent diameter of α Lyræ; and judging it of the greatest importance to increase my scale as much as convenient, I placed the micrometer at the greatest convenient distance, and (with some trouble, for want of longer handles, which might easily be added) took the diameter of this star by removing the two lucid points to such a distance as just to enclose the apparent diameter. When I measured my radius, it was found to be twenty-two feet six inches. The distance of the two lucid points was *about* three inches, for I will not pretend to *extreme* nicety in this observation, on account of the very great power I used, which was 6450. From these measures we have the magnified angle $38' 10''$: this divided by the power gives $0''.355$ for the apparent diameter of α Lyræ. The scale of the micrometer, on this occasion, was no less than 8.443 inches to a second, as will be found by multiplying the natural tangent of a second with the power and radius in inches.

"November 28. 1781, I measured the diameter of the new star; but the air was not very favourable, for this singular star was not so distinct with 227 that evening as it generally is with 460: therefore, without laying much stress upon the exactness of the observation, I shall only report it to exemplify the use of the micrometer. My radius was 35 feet 11 inches. The diameter of the star, by the distance of the lucid points, was 2.4 inches, and the power I used 227: hence the magnified angle is found $19'$, and the real diameter of the star $5''.022$. The scale of this measure .474 millesimals of an inch, or almost half an inch to a second."

In the Philosophical Transactions for 1791, a very simple micrometer for measuring small angles with the telescope is described by Mr Cavallo; who introduces his description with the following observations upon the different sorts of telescopic micrometers in use. "These instruments may be divided into two classes; namely, those which have not, and those which have, some movement amongst their parts. The micrometers of the former sort consist mostly of fine wires or hairs, variously disposed, and situated within the telescope, just where the image of the object is formed. In order to determine an angle with those micrometers, a good deal of calculation is generally required. The micrometers of the other sort, of which there is a great variety, some being made with moveable parallel wires, others with prisms, others again with a combination of lenses, and so on, are more or less subject to several inconveniences, the principal of which are the following. 1. Their motions generally depend upon the action of a screw; and of course the imperfections of its threads, and the greater or less quantity of lost motion, which is observable in moving a screw, especially when small, occasion a considerable error in the mensuration of angles. 2. Their complication and bulk renders them difficultly applicable to a variety of telescopes, especially to the pocket ones. 3. They do not measure the angle without some loss of time, which is necessary to turn the

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screw, or to move some other mechanism. 4. and lastly, They are considerably expensive, so that some of them cost even more than a tolerably good telescope."

After having had long in view (our author informs us) the construction of a micrometer which might be in part at least, if not entirely, free from all those objections; he, after various attempts, at last succeeded with a simple contrivance, which, after repeated trials, has been found to answer the desired end, not only from his own experience, but from that also of several friends, to whom it has been communicated.

This micrometer, in short, consists of a thin and narrow slip of mother-of-pearl finely divided, and situated in the focus of the eye-glass of a telescope, just where the image of the object is formed. It is immaterial whether the telescope be a refractor or a reflector, provided the eye-glass be a convex lens, and not a concave one as in the Galilean construction.

The simplest way of fixing it is to stick it upon the diaphragm which generally stands within the tube and in the focus of the eye-glass. When thus fixed, if you look through the eye-glass, the divisions of the micrometrical scale will appear very distinct, unless the diaphragm is not exactly in the focus; in which case, the micrometrical scale must be placed exactly in the focus of the eye-glass, either by pushing the diaphragm backwards or forwards, when that is practicable; or else the scale may be easily removed from one or the other surface of the diaphragm by the interposition of a circular piece of paper or card, or by a bit of wax. This construction is fully sufficient, when the telescope is always to be used by the same person; but when different persons are to use it, then the diaphragm which supports the micrometer must be constructed so as to be easily moved backwards or forwards, though that motion needs not be greater than about a tenth or an eighth of an inch. This is necessary, because the distance of the focus of the same lens appears different to the eyes of different persons; and, therefore, whoever is going to use the telescope for the mensuration of any angle, must first of all unscrew the tube which contains the eye-glass and micrometer from the rest of the telescope, and, looking through the eye-glass, must place the micrometer where the divisions of it may appear quite distinct to his eye.

In case that any person should not like to see always the micrometer in the field of the telescope, then the micrometrical scale, instead of being fixed to the diaphragm, may be fitted to a circular perforated plate of brass, wood, or even paper, which may be occasionally placed upon the said diaphragm.

Mr Cavallo has made several experiments to determine the most useful substance for this micrometer.—Glass, which he had successfully applied for a similar purpose to the compound microscope, seemed at first to be the most promising; but it was at last rejected after several trials: for the divisions upon it generally are either too fine to be perceived, or too rough; and though with proper care and attention the divisions may be proportioned to the sight, yet the thickness of the glass itself obstructs in some measure the distinct

view of the object. Ivory, horn, and wood, were found useless for the construction of this micrometer, on account of their bending, swelling, and contracting very easily; whereas mother-of-pearl is a very steady substance, the divisions upon it may be marked very easily, and when it is made as thin as common writing paper it has a very useful degree of transparency.

Fig. 19. exhibits this micrometer scale, but shows it four times larger than the real size of one, which he has adapted to a three-feet achromatic telescope that magnifies about 84 times. It is something less than the 24th part of an inch broad; its thickness is equal to that of common writing paper; and the length of it is determined by the aperture of the diaphragm, which limits the field of the telescope. The divisions upon it are the 200ths of an inch, which reach from one edge of the scale to about the middle of it, excepting every fifth and tenth division, which are longer. The divided edge of it passes through the centre of the field of view, though this is not a necessary precaution in the construction of this micrometer. Two divisions of the above described scale in my telescope are very nearly equal to one minute; and as a quarter of one of those divisions may be very well distinguished by estimation, therefore an angle of one eighth part of a minute, or of $7\frac{1}{2}''$, may be measured with it.

When a telescope magnifies more, the divisions of the micrometer must be more minute; and Mr Cavallo finds, that when the focus of the eye-glass of the telescope is shorter than half an inch, the micrometer may be divided with the 500ths of an inch; by means of which, and the telescope magnifying about 200 times, one may easily and accurately measure an angle smaller than half a second. On the other hand, when the telescope does not magnify above 30 times, the divisions need not be so minute: for instance, in one of Dollond's pocket telescopes, which when drawn out for use is about 14 inches long, a micrometer with the hundredths of an inch is quite sufficient, and one of its divisions is equal to little less than three minutes, so that an angle of a minute may be measured by it.

"In looking through a telescope furnished with such a micrometer (says our author), the field of view appears divided by the micrometer scale, the breadth of which occupies about one-seventh part of the aperture; and as the scale is semitransparent, that part of the object which happens to be behind it may be discerned sufficiently well to ascertain the division, and even the quarter of a division, with which its borders coincide. Fig. 20. shows the appearance of the field of my telescope with the micrometer, when directed to the title page of the Philosophical Transactions, wherein one may observe that the thickness of the letter C is equal to three-fourths of a division, the diameter of the O is equal to three divisions, and so on.

"At first view, one is apt to imagine, that it is difficult to count the divisions which may happen to cover or to measure an object; but upon trial it will be found, that this is readily performed; and even people who have never been used to observe with the telescope,

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scope, soon learn to measure very quickly and accurately with this micrometer; for since every fifth and tenth division is longer than the rest, one soon acquires the habit of saying, five, ten, fifteen; and then, by adding the other divisions less than five, completes the reckoning. Even with a telescope which has no stand, if the object end of it be rested against a steady place, and the other end be held by the hand near the eye of the observer, an object may be measured with accuracy sufficient for several purposes, as for the estimation of small distances, for determining the height of a house, &c.

"After having constructed and adapted this micrometer to the telescope, it is then necessary to ascertain the value of the divisions. It is hardly necessary to mention in this place, that though those divisions measure the chords of the angles, and not the angles or arches themselves, and the chords are not as the arches, yet it has been shown by all the trigonometrical writers, that in small angles the chords, arches, sines, and tangents, follow the same proportion so very nearly, that the very minute difference may be safely neglected: so that if one division of this micrometer is equal to one minute, we may safely conclude, that two divisions are equal to two minutes, three divisions to three minutes, and so on. There are various methods of ascertaining the value of the divisions of such a micrometer, they being the very same that are used for ascertaining the value of the divisions in other micrometers. Such are, the passage of an equatorial star over a certain number of divisions in a certain time; or the measuring of the diameter of the sun, by computation from the focal distance of the object and other lenses of the telescope; the last of which, however, is subject to several inaccuracies; but as they are well known to astronomical persons, and have been described in many books, they need not be farther noticed here. However, for the sake of workmen and other persons not conversant in astronomy, I shall describe an easy and accurate method of ascertaining the value of the divisions of the micrometer.

"Mark upon a wall or other place the length of six inches, which may be done by making two dots or lines six inches asunder, or by fixing a six-inch ruler upon a stand; then place the telescope before it so that the ruler or six-inch length may be at right angles with the direction of the telescope, and just 57 feet $3\frac{1}{2}$ inches distant from the object glass of the telescope: this done, look through the telescope at the ruler or other extension of six inches, and observe how many divisions of the micrometer are equal to it, and that same number of divisions is equal to half a degree, or $30'$; and this is all that needs be done for the required determination; the reason of which is, because an extension of six inches subtends an angle of $30'$ at the distance of 57 feet $3\frac{1}{2}$ inches, as may be easily calculated by the rules of plane trigonometry.

"In one of Dollond's 14-inch pocket telescopes, if the divisions of the micrometer be the hundredths of an inch, $11\frac{1}{2}$ of those divisions will be found equal to $30'$, or 23 to a degree. When this value has been once ascertained, any other angle measured by any other number of divisions is determined by the rule

of three. Thus, suppose that the diameter of the sun seen through the same telescope, be found equal to 12 divisions, say as $11\frac{1}{2}$ divisions are to 30 minutes,

so are 12 divisions to $\left(\frac{12 \times 30}{11.5}\right) 31.3$, which is the required diameter of the sun.

"Notwithstanding the facility of this calculation, a scale may be made answering to the divisions of a micrometer, which will show the angle corresponding to any number of divisions to mere inspection. Thus, for the above-mentioned small telescope, the scale is represented in fig. 21. AB is a line drawn at pleasure; it is then divided into 23 equal parts, and those divisions which represent the divisions of the micrometer that are equal to one degree, are marked on one side of it. The line then is divided again into 60 equal parts, which are marked on the other side of it; and these divisions represent the minutes which correspond to the divisions of the micrometer: thus the figure shows, that six divisions of the micrometer are equal to $15\frac{1}{2}$ minutes, $11\frac{1}{2}$ divisions are nearly equal to 29 minutes, &c. What has been said of minutes may be said of seconds also, when the scale is to be applied to a large telescope.

"Thus far this micrometer and its general use have been sufficiently described; and mathematical persons may easily apply it to the various purposes to which micrometers have been found subservient. But as the simplicity, cheapness, and at the same time the accuracy of this contrivance, may render the use of it much more general than that of any other micrometer; and I may venture to say, that it will be found very useful in the army, and amongst sea-faring people, for the determination of distances, heights, &c.; I shall therefore join some practical rules to render this micrometer useful to persons unacquainted with trigonometry and the use of logarithms.

"Problem 1. The angle, not exceeding one degree, which is subtended by an extension of one foot, being given, to find its distance from the place of observation. N. B. This extension of one foot, or any other which may be mentioned hereafter, must be perpendicular to the direction of the telescope through which it is observed. The distances are reckoned from the object-glass of the telescope; and the answers obtained by the rules of this problem, though not exactly true, are however so little different from the truth, that the difference seldom amounts to more than two or three inches, which may be safely neglected.

"Rule 1. If the angle be expressed in minutes, say, as the given angle is to 60, so is 687.55 to a fourth proportional, which gives the answer in inches. —2. If the angle be expressed in seconds, say, as the given angle is to 3600, so is 687.55 to a fourth proportional, which expresses the answer in inches. —3. If the angle be expressed in minutes and seconds, turn it all into seconds, and proceed as above.

"Example. At what distance is a globe of one foot in diameter when it subtends an angle of two seconds?

$$2 : 3600 :: 687.55 : \frac{3600 \times 687.55}{2} = 1237590$$

inches, or 10313 $2\frac{1}{2}$ feet, which is the answer required.

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MICROMETER.

Plate CCXCVI.

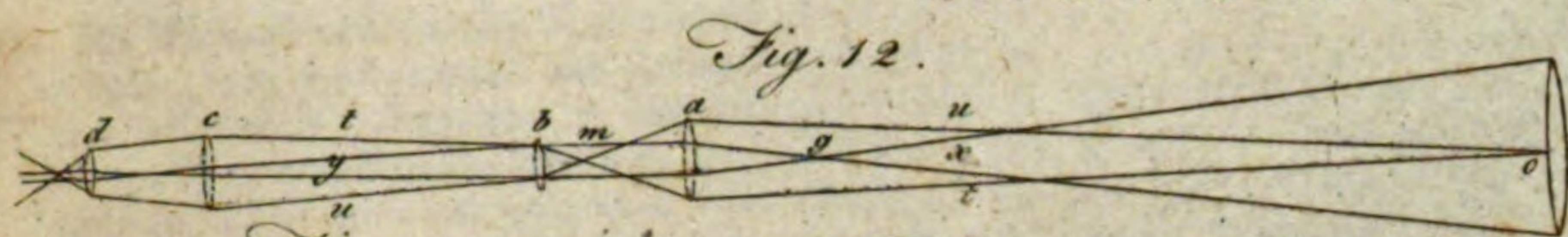


Fig. 12.

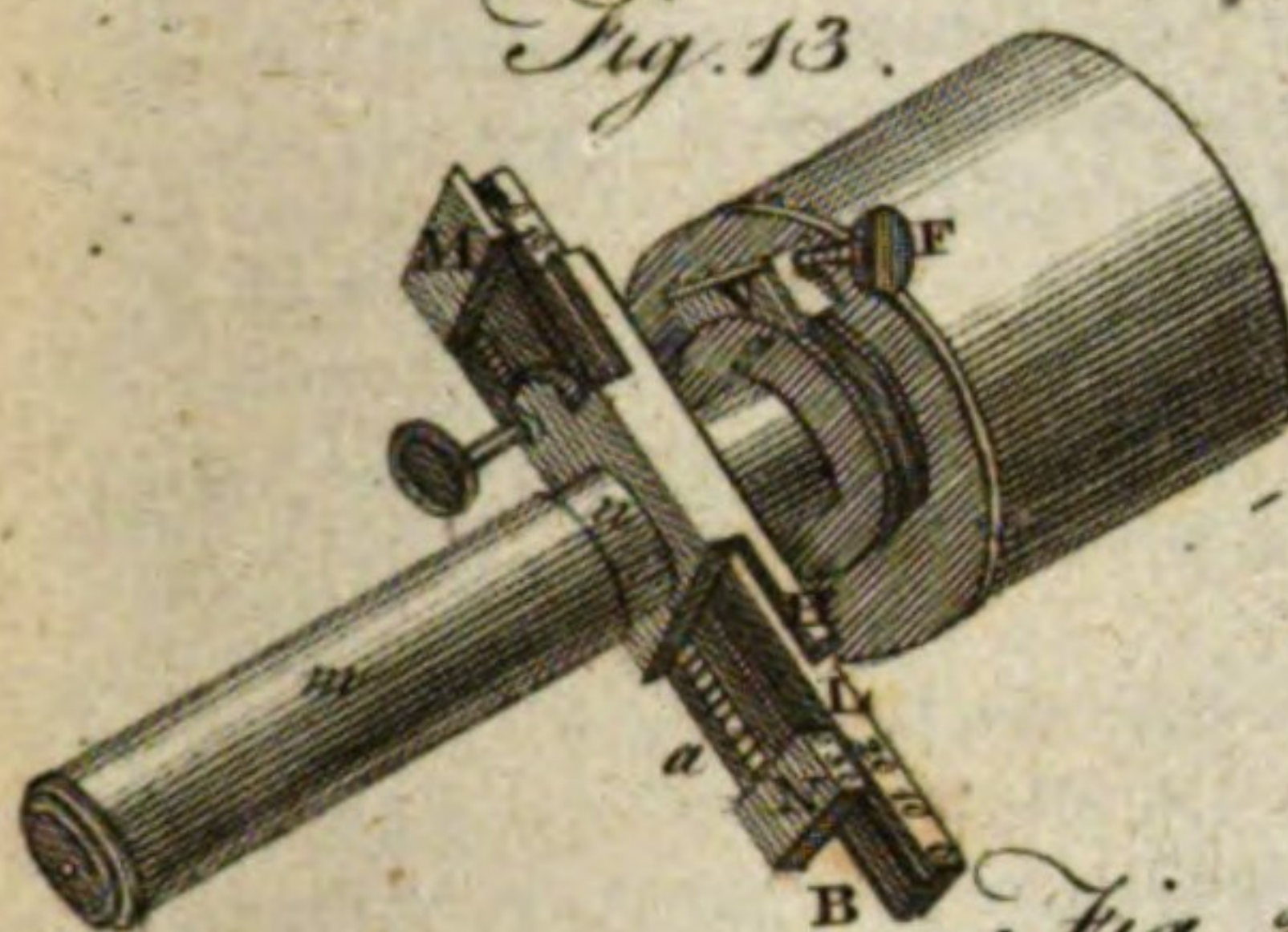


Fig. 13.



Fig. 23.

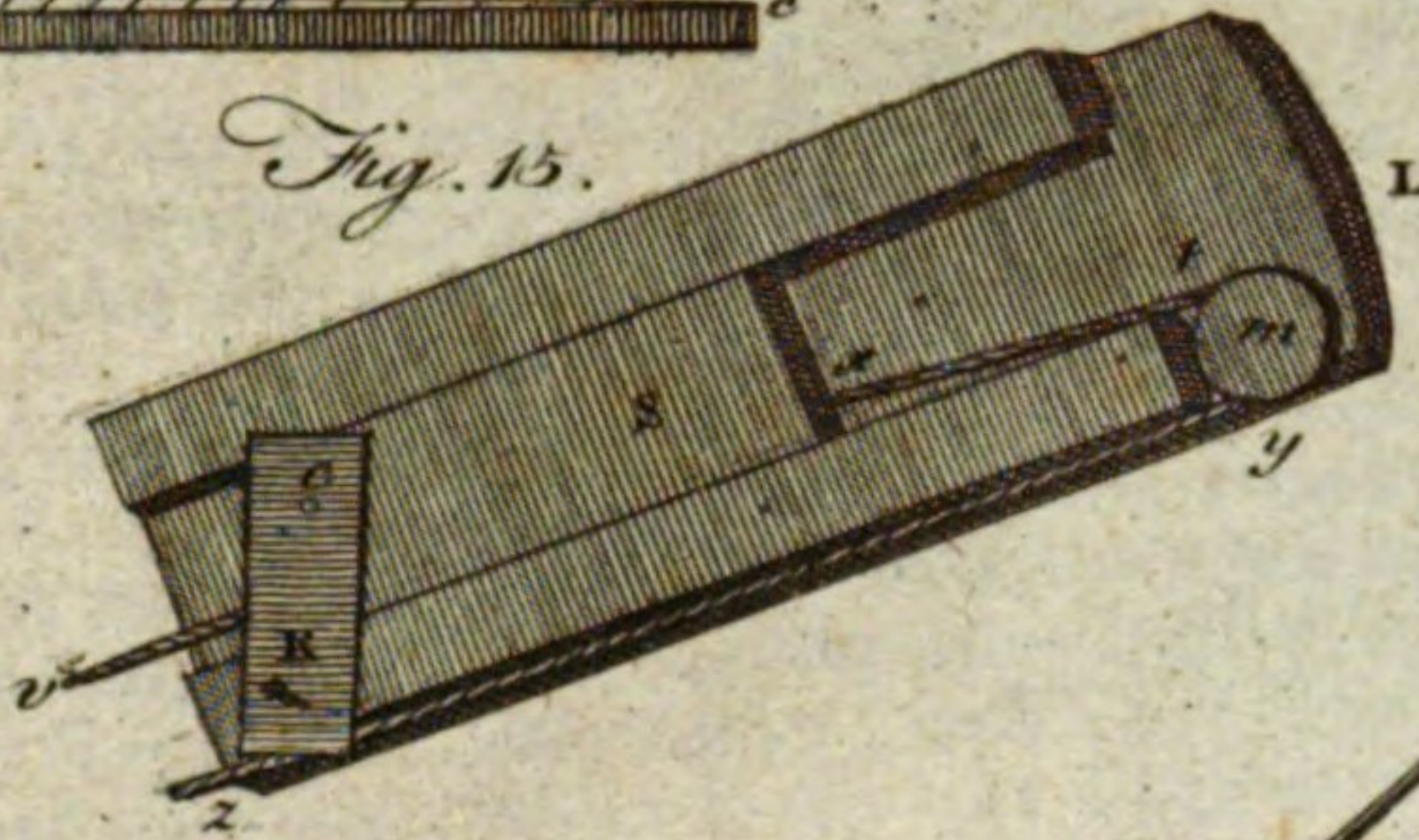


Fig. 15.



Fig. 22.

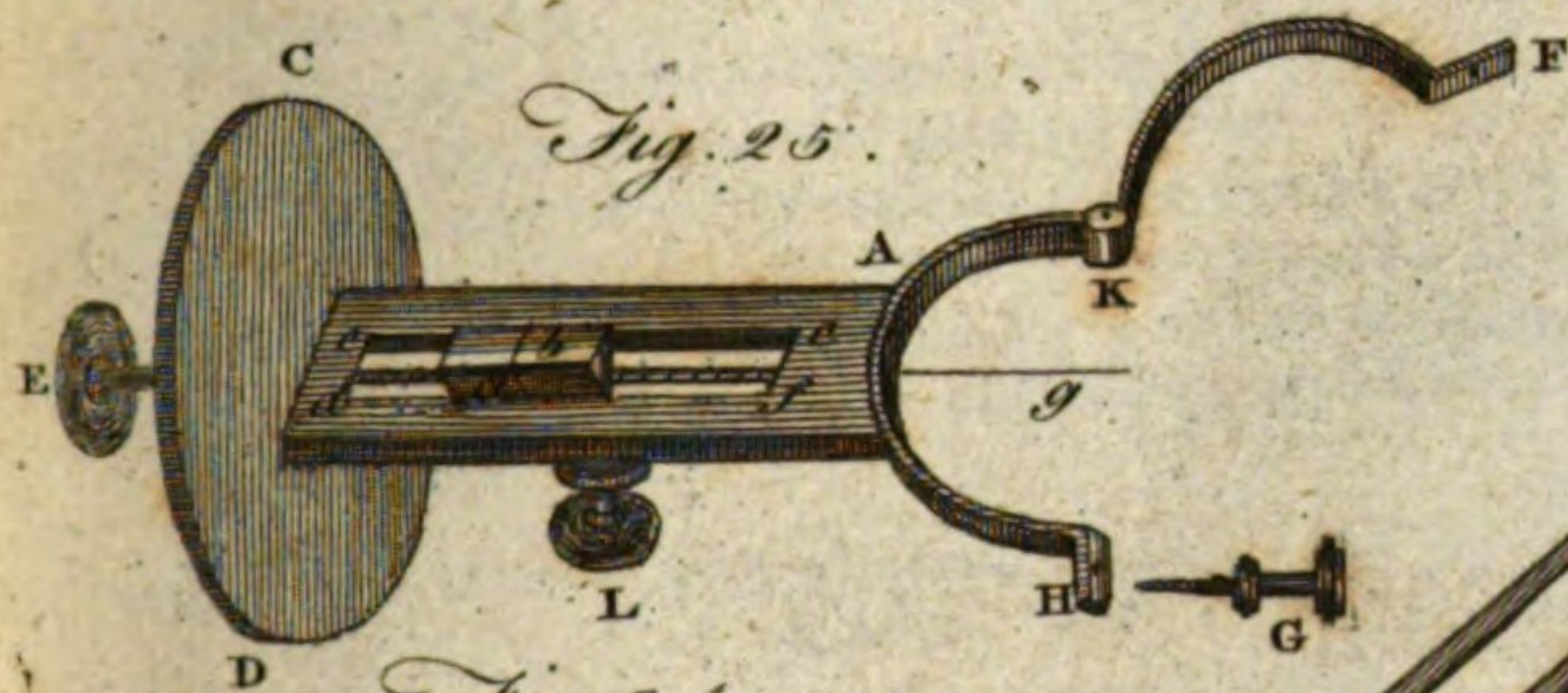


Fig. 25.

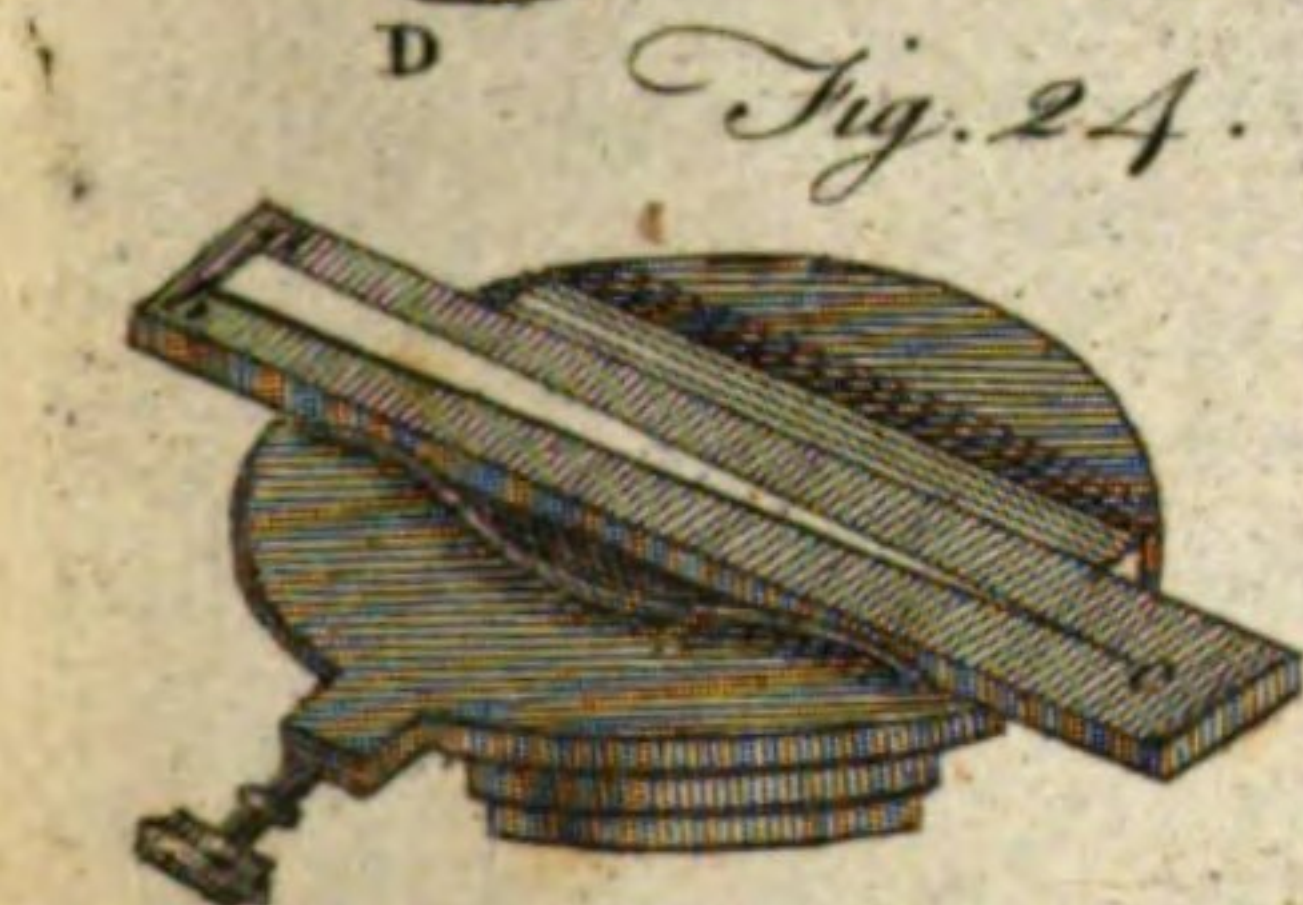


Fig. 24.

Fig. 20.

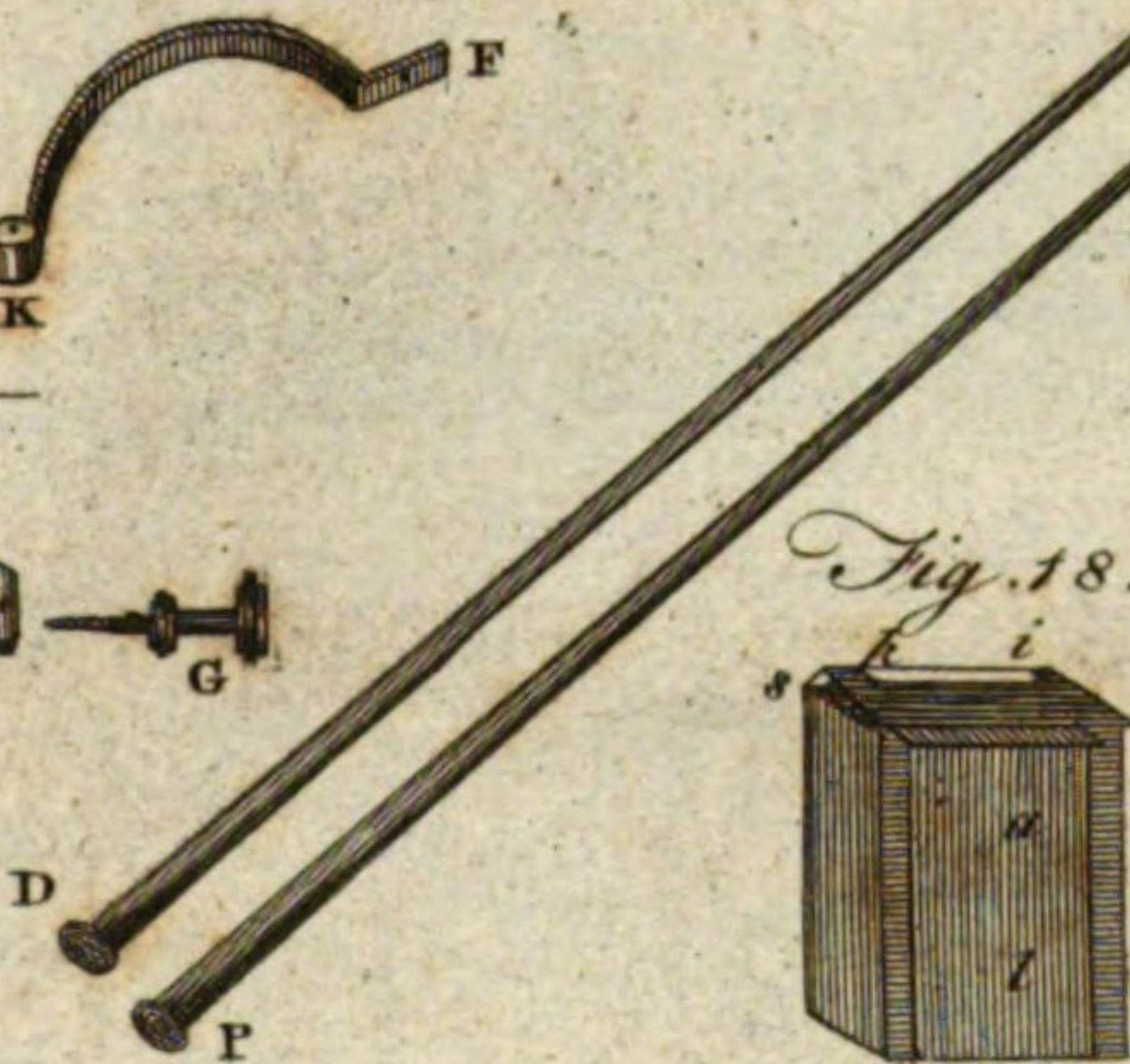


Fig. 18.

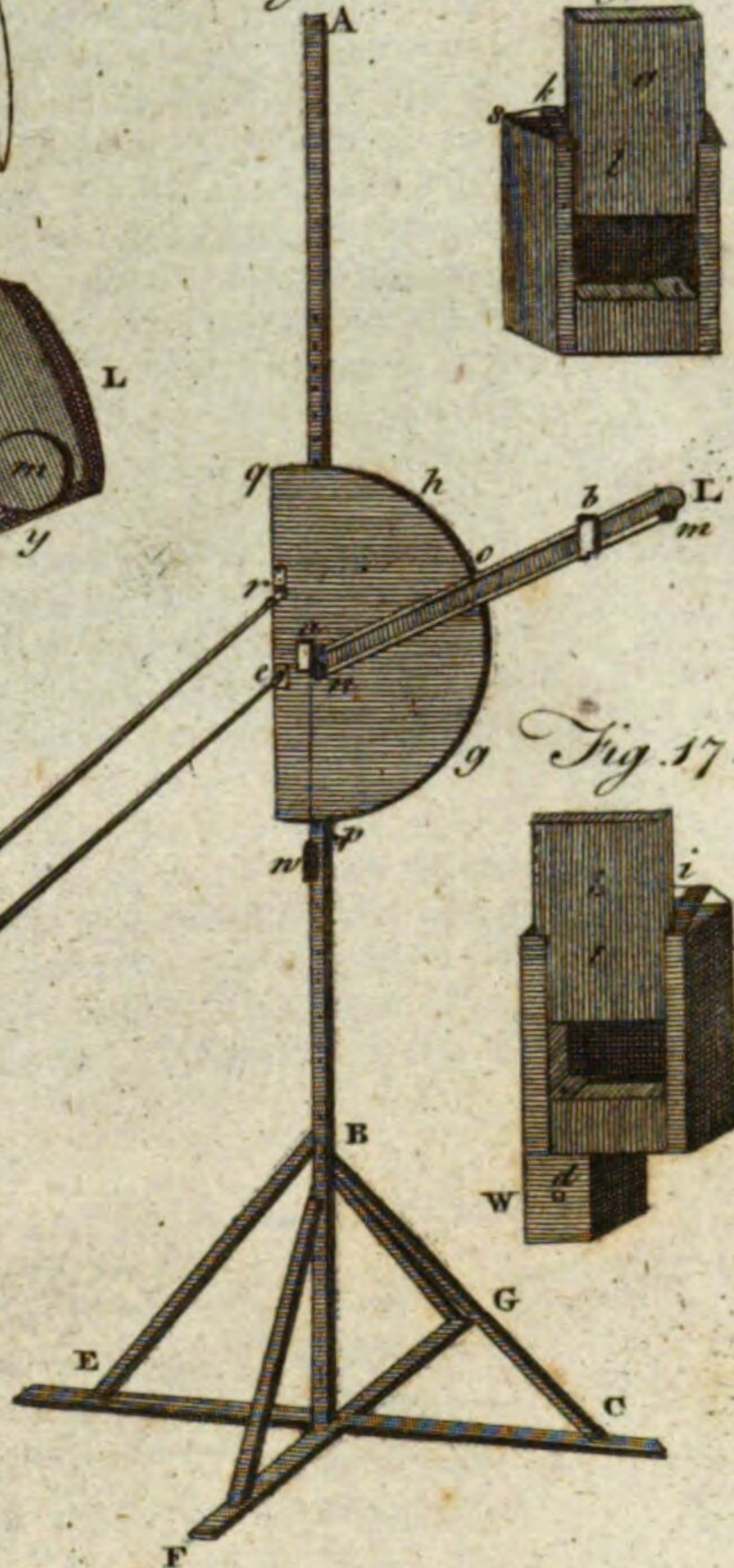


Fig. 14.



Fig. 16.

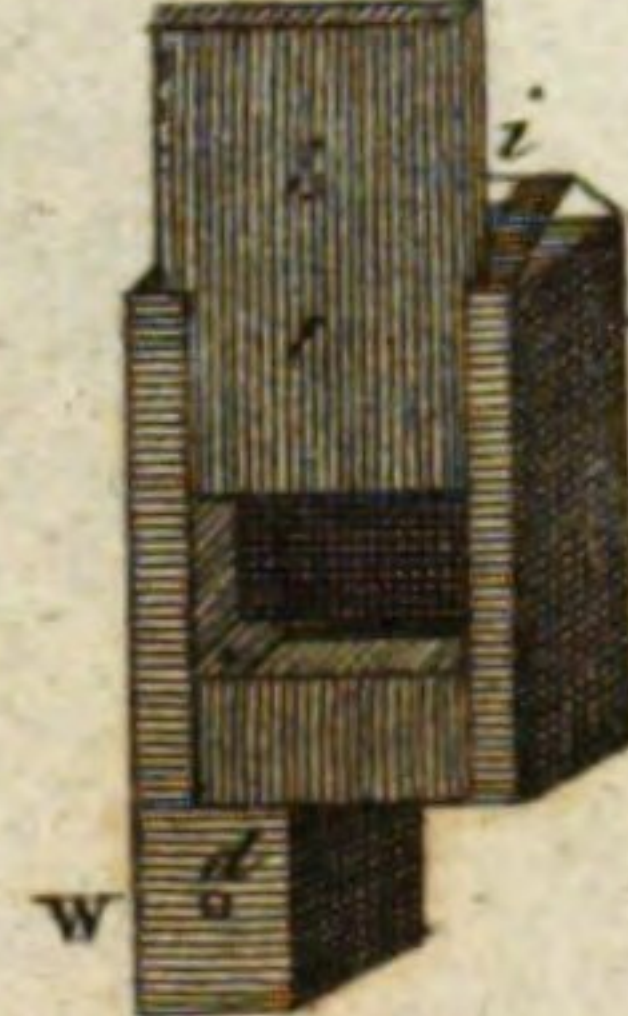


Fig. 17.

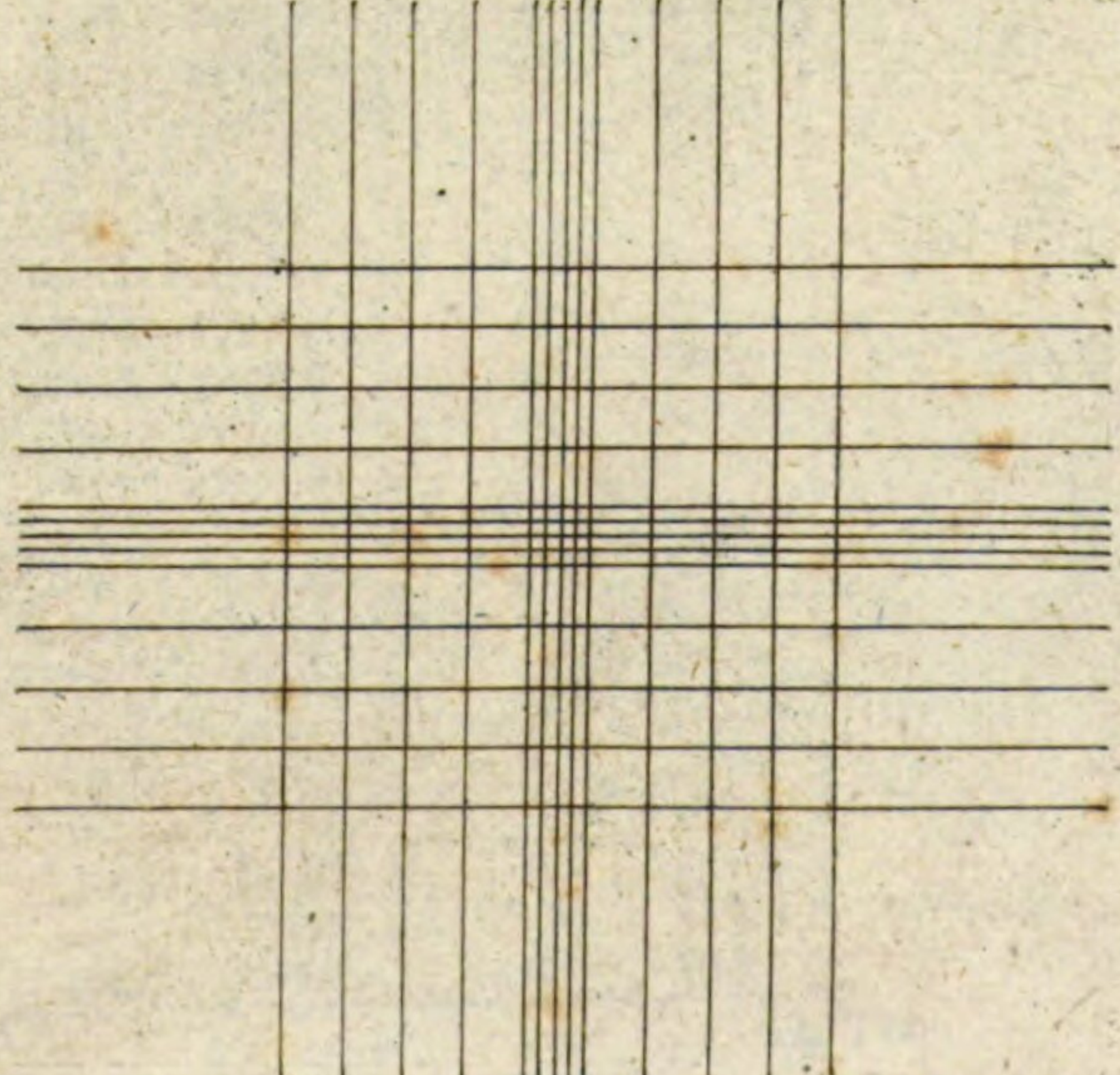


Fig. 19.

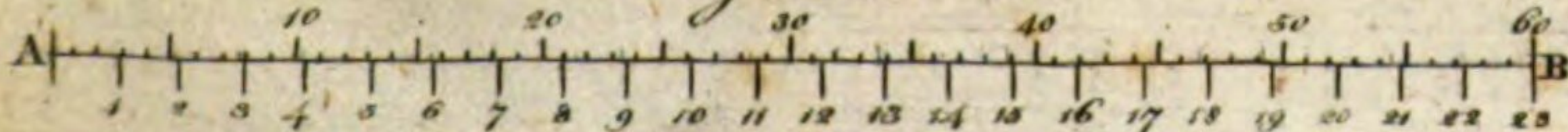
Fig. 26.



Fig. 21.



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"This calculation may be shortened; for since two of the three proportionals are fixed, their product in the first case is 41253, and in the other two cases is 2475180; so that in the first case, viz. when the angle is expressed in minutes, you need only divide 41253 by the given angle; and in the other two cases, viz. when the angle is expressed in seconds, divide 2475180 by the given angle, and the quotient in either case is the answer in inches.

"Problem II. The angle, not exceeding one degree, which is subtended by any known extension, being given, to find its distance from the place of observation.

"Rule. Proceed as if the extension were of one foot by Problem I. and call the answer B; then, if the extension in question be expressed in inches, say, as 12 inches are to that extension, so is B to a fourth proportional, which is the answer in inches; but if the extension in question be expressed in feet, then you need only multiply it by B, and the product is the answer in inches.

"Example. At what distance is a man six feet high, when he appears to subtend an angle of 30'.

"By problem I. if the man were one foot high, the distance would be 82506 inches; but as he is six feet high, therefore multiply 82506 by 6, and the product gives the required distance, which is 495036 inches, or 41253 feet.

Angles subtended by an extension of one foot at different distances.

Angles.	Distances in feet.	Angles.	Distances in feet.
Min. 1	3437,7	Min. 31	110,9
2	1718,9	32	107,4
3	1145,9	33	104,2
4	859,4	34	101,1
5	687,5	35	98,2
6	572,9	36	95,5
7	491,1	37	92,9
8	429,7	38	90,4
9	382,0	39	88,1
10	343,7	40	85,9
11	312,5	41	83,8
12	286,5	42	81,8
13	264,4	43	79,9
14	245,5	44	78,1
15	229,2	45	76,4
16	214,8	46	74,7
17	202,2	47	73,1
18	191,0	48	71,6
19	180,9	49	70,1
20	171,8	50	68,7
21	162,7	51	67,4
22	156,2	52	66,1
23	149,4	53	64,8
24	143,2	54	63,6
25	137,5	55	62,5
26	132,2	56	61,4
27	127,3	57	60,3
28	122,7	58	59,2
29	118,5	59	58,2
30	114,6	60	57,3

"For greater convenience, especially in travelling, or in such circumstances in which one has not the opportunity of making even the easy calculations required in those problems, I have calculated the following two tables; the first of which shows the distance answering to any angle from one minute to one degree, which is subtended by an extension of one foot; and the second table shows the distance answering to any angle from one minute to one degree, which is subtended by a man, the height of which has been called an extension of six feet; because, at a mean, such is the height of a man when dressed with hat and shoes on. These tables may be transcribed on a card, and may be had always ready with a pocket telescope furnished with a micrometer. Their use is evidently to ascertain distances without any calculation; and they are calculated only to minutes, because with a pocket telescope and micrometer it is not possible to measure an angle more accurately than to a minute.

"Thus, if one wants to measure the extension of a street, let a foot ruler be placed at the end of the street; measure the angular appearance of it, which suppose to be 36', and in the table you will have the required distance against 36', which is 95½ feet. Thus also a man who appears to be 49' high, is at the distance of 421 feet.

Microm-
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Angles subtended by an extension of six feet at different distances.

Angles.	Distances in feet.	Angles.	Distances in feet.
Min. 1	20626,8	Min. 31	665,4
2	10313,	32	644,5
3	6875,4	33	625,
4	5156,5	34	606,6
5	4125,2	35	589,3
6	3437,7	36	572,9
7	2946,6	37	557,5
8	2578,2	38	542,8
9	2291,8	39	528,9
10	2062,6	40	515,6
11	1875,2	41	503,1
12	1718,8	42	491,1
13	1586,7	43	479,7
14	1473,3	44	468,8
15	1375,	45	458,4
16	1298,1	46	448,4
17	1213,3	47	438,9
18	1145,9	48	429,7
19	1085,6	49	421,
20	1031,4	50	412,5
21	982,2	51	404,4
22	937,6	52	396,7
23	896,8	53	389,2
24	859,4	54	381,9
25	825,	55	375,
26	793,3	56	368,3
27	763,9	57	361,9
28	736,6	58	355,6
29	711,3	59	349,6
30	687,5	60	343,7

Micrometer.

II. The Micrometer has not only been applied to telescopes, and employed for astronomical purposes; but there have also been various contrivances for adapting it to MICROSCOPICAL observations. Mr Leeuwenhoek's method of estimating the size of small objects was by comparing them with grains of sand, of which 100 in a line took up an inch. These grains he laid upon the same plate with his objects, and viewed them at the same time. Dr Jurin's method was similar to this; for he found the diameter of a piece of fine silver wire, by wrapping it as close as he could about a pin, and observing how many rings made an inch; and he used this wire in the same manner as Leeuwenhoek used his sand. Dr Hooke used to look upon the magnified object with one eye, while at the same time he viewed other objects placed at the same distance with the other eye. In this manner he was able, by the help of a ruler, divided into inches and small parts, and laid on the pedestal of the microscope, to cast as it were the magnified appearance of the object upon the ruler, and thus exactly to measure the diameter which it appeared to have through the glass; which being compared with the diameter as it appeared to the naked eye, easily showed the degree in which it was magnified. A little practice, says Mr Baker, will render this method exceedingly easy and pleasant.

Mr Martin in his Optics recommended such a micrometer for a microscope as had been applied to telescopes: for he advises to draw a number of parallel lines on a piece of glass, with the fine point of a diamond, at the distance of one-fortieth of an inch from one another, and to place it in the focus of the eye-glass. By this method, Dr Smith contrived to take the exact draught of objects viewed by a double microscope; for he advises to get a lattice, made with small silver wires or squares, drawn upon a plain glass by the strokes of a diamond, and to put it into the place of the image, formed by the object-glass: then by transferring the parts of the object, seen in the squares of the glass or lattice upon similar corresponding squares drawn on paper, the picture may be exactly taken. Mr Martin also introduced into compound microscopes another micrometer, consisting of a screw. See both these methods described in his *Optics*, p. 277.

* Microscopical Essays, p. 59.

The mode of actual admeasurement (Mr Adams observes*) is without doubt the most simple that can be used; as by it we comprehend, in a manner, at one glance, the different effects of combined glasses; and as it saves the trouble, and avoids the obscurity, of the usual modes of calculation: but many persons find it exceedingly difficult to adopt this method, because they have not been accustomed to observe with both eyes at once. To obviate this inconvenience, the late Mr Adams contrived an instrument called the *Needle-Micrometer*, which was first described in his *Micrographia Illustrata*; and of which, as now constructed, we have the following description by his son Mr George Adams in the ingenious Essays above quoted.

This micrometer consists of a screw, which has 50 threads to an inch; this screw carries an index, which points to the divisions on a circular plate, which is fixed at right angles to the axis of the screw. The revolutions of the screw are counted on a scale, which is an inch divided into 50 parts; the index to these divisions is a flower-de-luce marked upon the slider, which

carries the needle point across the field of the microscope. Every revolution of the micrometer screw measures $\frac{1}{50}$ th part of an inch, which is again subdivided by means of the divisions on the circular plate, as this is divided into 20 equal parts, over which the index passes at every revolution of the screw; by which means we obtain with ease the measure of 1000th part of an inch: for 50, the number of threads on the screw in one inch, being multiplied by 20, the divisions on the circular plate are equal to 1000; so that each division on the circular plate shows that the needle has either advanced or receded 1000th part of an inch.

To place this micrometer on the body of the microscope, open the circular part FKH, fig. 25. by taking out the screw G, throw back the semicircle FK, which moves upon a joint at K; then turn the sliding tube of the body of the microscope, so that the small holes which are in both tubes may exactly coincide, and let the needle *g* of the micrometer have a free passage through them; after this, screw it fast upon the body by the screw G. The needle will now traverse the field of the microscope, and measure the length and breadth of the image of any object that is applied to it. But further assistance must be had, in order to measure the object itself, which is a subject of real importance; for though we have ascertained the power of the microscope, and know that it is so many thousand times, yet this will be of little assistance towards ascertaining an accurate idea of its real size; for our ideas of bulk being formed by the comparison of one object with another, we can only judge of that of any particular body, by comparing it with another whose size is known: the same thing is necessary, in order to form an estimate by the microscope; therefore, to ascertain the real measure of the object, we must make the point of the needle pass over the image of a known part of an inch placed on the stage, and write down the revolutions made by the screw, while the needle passed over the image of this known measure; by which means we ascertain the number of revolutions on the screw, which are adequate to a real and known measure on the stage. As it requires an attentive eye to watch the motion of the needle point as it passes over the image of a known part of an inch on the stage, we ought not to trust to one single measurement of the image, but ought to repeat it at least six times; then add the six measures thus obtained together, and divide their sum by six, or the number of trials; the quotient will be the mean of all the trials. This result is to be placed in a column of a table next to that which contains the number of the magnifiers.

By the assistance of the sectoral scale, we obtain with ease a small part of an inch. This scale is shown at fig. 22, 23, 24, in which the two lines *ca*, *cb*, with the side *ab*, form an isosceles triangle; each of the sides is two inches long, and the base still only of one-tenth of an inch. The longer sides may be of any given length, and the base still only of one-tenth of an inch. The longer lines may be considered as the line of lines upon a sector opened to one-tenth of an inch. Hence whatever number of equal parts *ca*, *cb* are divided into, their transverse measure will be such a part of one-tenth as is expressed by their divisions. Thus if it be divided into ten equal parts, this will divide the

Micrometer.

Plate CCXCV.

Microme-
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the inch into 100 equal parts; the first division next *c* will be equal to 100th part of an inch, because it is the tenth part of one-tenth of an inch. If these lines are divided into twenty equal parts, the inch will be by that means divided into 200 equal parts. Lastly, if *ab*, *ca*, are made three inches long, and divided into 100 equal parts, we obtain with ease the 1000th part. The scale is represented as solid at fig. 23. but as perforated at fig. 22. and 24. so that the light passes thro' the aperture, when the sectoral part is placed on the stage.

To use this scale, first fix the micrometer, fig. 25. to the body of the microscope; then fit the sectoral scale, fig. 24. in the stage, and adjust the microscope to its proper focus or distance from the scale, which is to be moved till the base appears in the middle of the field of view; then bring the needle point *g*, fig. 25. (by turning the screw *L*) to touch one of the lines *ca*, exactly at the point answering to 20 on the sectoral scale. The index *a* of the micrometer is to be set to the first division, and that on the dial plate to 20, which is both the beginning and end of its divisions; we are then prepared to find the magnifying power of every magnifier in the compound microscope which we are using.

Example. Every thing being prepared agreeable to the foregoing directions, suppose you are desirous of ascertaining the magnifying power of the lens marked N^o 4. turn the micrometer screw until the point of the needle has passed over the magnified image of the tenth part of one inch; then the division, where the two indices remain, will show how many revolutions, and parts of a revolution, the screw has made, while the needle point traversed the magnified image of the one-tenth of an inch; suppose the result to be 26 revolutions of the screw, and 14 parts of another revolution, this is equal to 26 multiplied by 20, added to 14; that is, 534,000 parts of an inch.—The 26 divisions found on the straight scale of the micrometer, while the point of the needle passed over the magnified image of one-tenth part of an inch, were multiplied by 20, because the circular plate *CD*, fig. 25. is divided into 20 equal parts; this produced 520; then adding the 14 parts of the next revolution, we obtain the 534,000 parts of an inch, or five-tenths and 3400 parts of another tenth, which is the measure of the magnified image of one-tenth of an inch, at the aperture of the eye-glasses or at their foci. Now if we suppose the focus of the two eye-glasses to be one inch, the double thereof is two inches; or if we reckon in the 1000th part of an inch, we have 2000 parts for the distance of the eye from the needle point of the micrometer. Again, if we take the distance of the image from the object at the stage at 6 inches, or 6000, and add thereto 2000, double the distance of the focus of the eye-glass, we shall have 8000 parts of an inch for the distance of the eye from the object; and as the glasses double the image, we must double the number 534 found upon the micrometer, which then makes 1068: then, by the following analogy, we shall obtain the number of times the microscope magnifies the diameter of the object; say, as 240, the distance of the eye from the image of the object, is to 800, the distance of the eye from the object; so is 1068, double the measure found on the micrometer, to 3563, or the

number of times the microscope magnifies the diameter of the object. By working in this manner, the magnifying power of each lens used with the compound microscope may be easily found, though the result will be different in different compound microscopes, varying according to the combination of the lenses, their distance from the object and one another, &c.

Having discovered the magnifying power of the microscope, with the different object-lenses that are used therewith, our next subject is to find out the real size of the objects themselves, and their different parts: this is easily effected, by finding how many revolutions of the micrometer-screw answer to a known measure on the sectoral scale or other object placed on the stage; from the number thus found, a table should be constructed, expressing the value of the different revolutions of the micrometer with that object lens, by which the primary number was obtained. Similar tables must be constructed for each object lens. By a set of tables of this kind, the observer may readily find the measure of any object he is examining; for he has only to make the needle point traverse over this object, and observe the number of revolutions the screw has made in its passage, and then look into his table for the real measure which corresponds to this number of revolutions, which is the measure required.

Mr Coventry of Southwark has favoured us with the description of a micrometer of his own invention; the scale of which, for minuteness, surpasses every instrument of the kind of which we have any knowledge, and of which, indeed, we could scarcely have formed a conception, had he not indulged us with several of these instruments, graduated as underneath.

The micrometer is composed of glass, ivory, silver, &c. on which are drawn parallel lines from the 10th to the 10,000th part of an inch. But an instrument thus divided, he observes, is more for curiosity than use: but one of those which Mr Coventry has sent us is divided into squares, so small that sixteen million of them are contained on the surface of one square inch, each square appearing under the microscope true and distinct; and though so small, it is a fact, that animalcula are found which may be contained in one of these squares.

The use of micrometers, when applied to microscopes, is to measure the natural size of the object, and how much that object is magnified. To ascertain the real size of an object in the single microscope, nothing more is required than to lay it on the micrometer, and adjust it to the focus of the magnifier, noticing how many divisions of the micrometer it covers. Suppose the parallel lines of the micrometer to be the 1000th of an inch, and the object covers two divisions; its real size is 500ths of an inch; if five, 200ths, and so on.

But to find how much the object is magnified, is not mathematically determined so easily by the single as by the compound microscope: but the following simple method (says Mr Coventry) I have generally adopted, and think it tolerably accurate. Adjust a micrometer under the microscope *o*, say the 100th of an inch of divisions, with a small object on it; if square, the better: notice how many divisions one side of the object covers, suppose 10: then cut a piece

Microm-
eter.

of white paper something larger than the magnified appearance of the object: then fix one eye on the object through the microscope, and the other at the same time on the paper, lowering it down till the object and the paper appear level and distinct: then cut the paper till it appear exactly the size of the magnified object; the paper being then measured, suppose an inch square: Now, as the object under the magnifier, which appeared to be one inch square, was in reality only ten hundredths, or the tenth of an inch, the experiment proves that it is magnified ten times in length, one hundred times in superficies, and one thousand times in cube, which is the magnifying power of the glass; and, in the same manner, a table may be made of the power of all the other glasses.

In using the compound microscope, the real size of the object is found by the same method as in the single: but to demonstrate the magnifying power of each glass to greater certainty, adopt the following method.—Lay a two-foot rule on the stage, and a micrometer level with its surface (an inch suppose, divided into 100 parts): with one eye see how many of those parts are contained in the field of the microscope, (suppose 50); and with the other, at the same time, look for the circle of light in the field of the microscope, which with a little practice will soon appear distinct; mark how much of the rule is intersected by the circle of light, which will be half the diameter of the field. Suppose eight inches; consequently the whole diameter will be sixteen. Now, as the real size of the field, by the micrometers, appeared to be only 50 hundredths, or half an inch, and as half an inch is only one 32d part of 16 inches, it shows the magnifying power of the glass to be 32 times in length, 1024 superficies, and 32,768 cube (E).

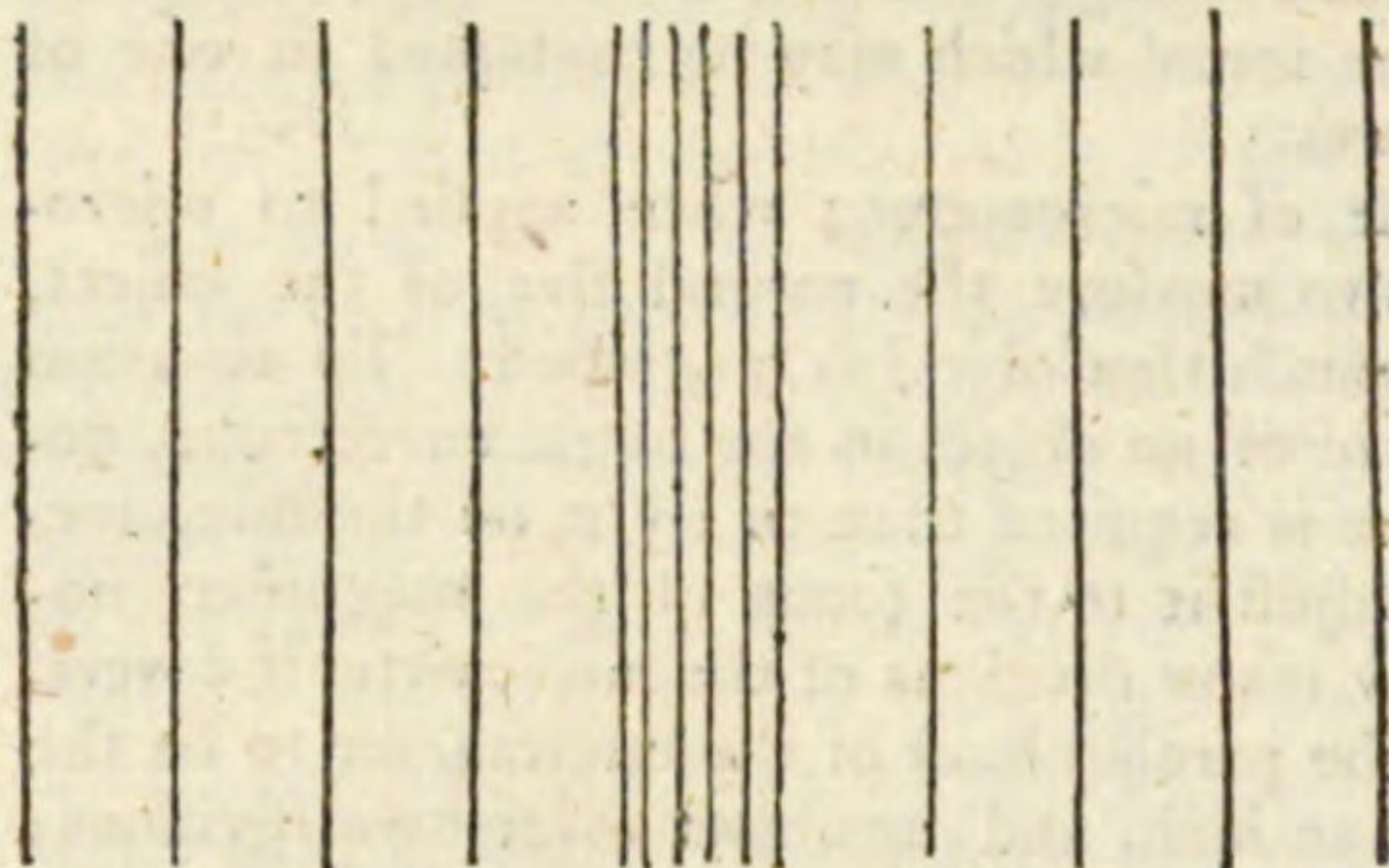
Another way of finding the magnifying power of compound microscopes, is by using two micrometers of the same divisions; one adjusted under the magnifier, the other fixed in the body of the microscope in the focus of the eye-glass. Notice how many divisions of the micrometer in the body are seen in one

division of the micrometer under the magnifier, which again must be multiplied by the power of the eye-glass. Example: Ten divisions of the micrometer in the body are contained in one division under the magnifier; so far the power is increased ten times: now, if the eye-glass be one inch focus, such glass will of itself magnify about eight times in length, which, with the ten times magnified before, will be eight times ten, or 80 times in length, 6400 superficies, and 512,000 cube.

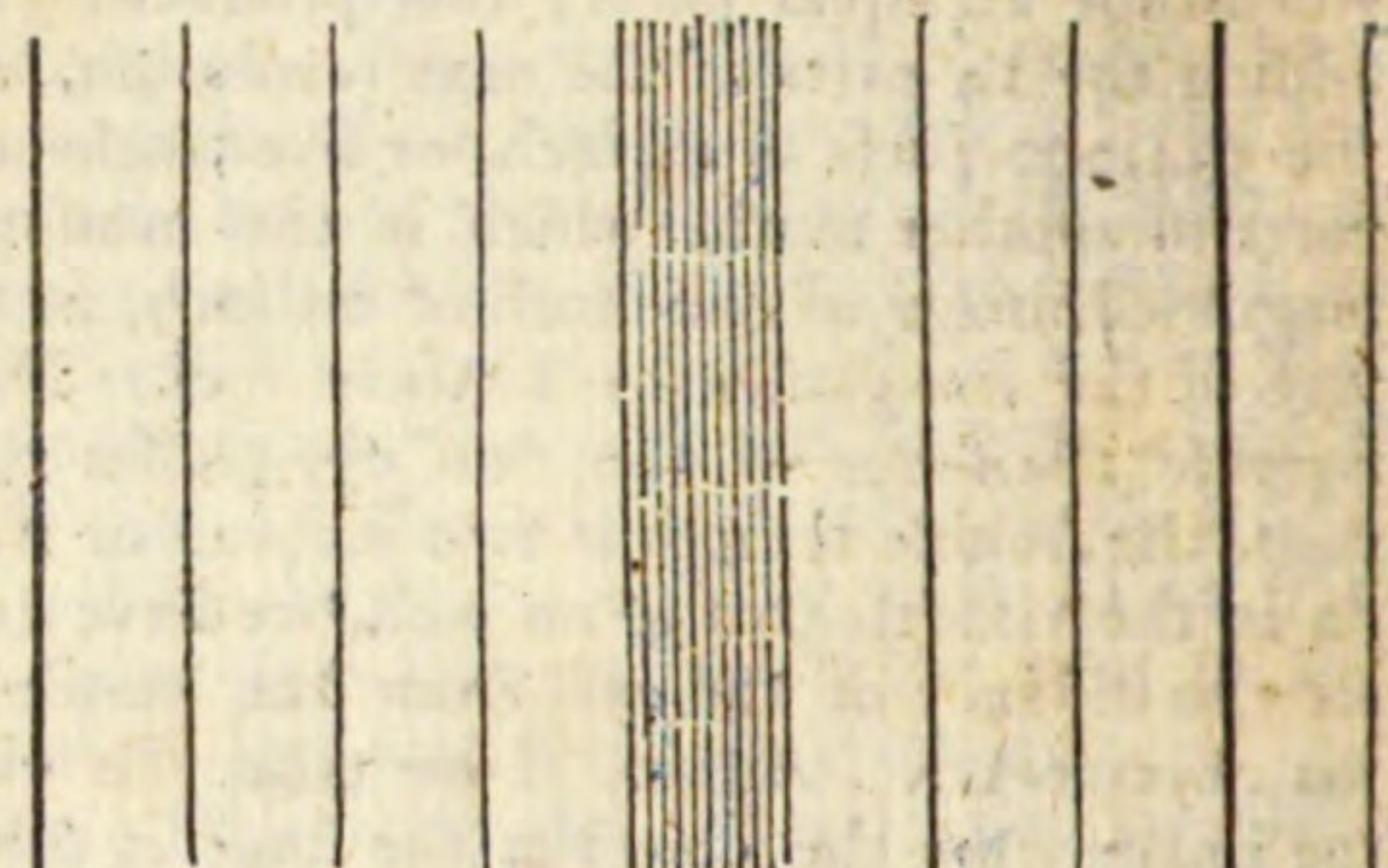
“If (says Mr Coventry) these micrometers are employed in the solar microscope, they divide the object into squares on the screen in such a manner as to render it extremely easy to make a drawing of it. And (says he) I apprehend they may be employed to great advantage with such a microscope as Mr Adams's Lucernal; because this instrument may be used either by day or night, or in any place, and gives the actual magnifying power without calculation.”

The case with which we have been favoured by Mr Coventry contains six micrometers, two on ivory and four on glass. One of those on ivory is an inch divided into one hundred parts, every fifth line longer than the intermediate one, and every tenth longer still, for the greater ease in counting the divisions under the microscope, and is generally used in measuring the magnifying power of microscopes. The other ivory one is divided into squares of the 50th and 100th of an inch, and is commonly employed in measuring opaque objects.

Those made of glass are for transparent objects, which, when laid on them, show their natural size.—That marked on the brass 100, are squares divided to the 100th of an inch: that marked 5000 are parallel lines forming nine divisions, each division the 1000th of an inch; the middle division is again divided into 5, making divisions to the 5000th of an inch. That marked 10,000 is divided in the same manner, with the middle division divided into 10, making the 10,000th of an inch. Example:



The glass micrometer without any mark is also divided, the outside lines into 100th, the next into 1000th, and the inside lines into the 4000th of an inch: these are again crossed with an equal number of



lines in the same manner, making squares of the 100th, 1000th, and 4000th of an inch, thus demonstrating each other's size. The middle square of the 1000th of an inch (see fig. 26.) is divided into sixteen squares; now

(E) It will be necessary, for great accuracy, as well as for comparative observations, that the two-foot rule should always be placed at a certain distance from the eye: eight inches would, in general, be a proper distance.

MICROSCOPE.

Plate CCXCVII.

Fig. 1.

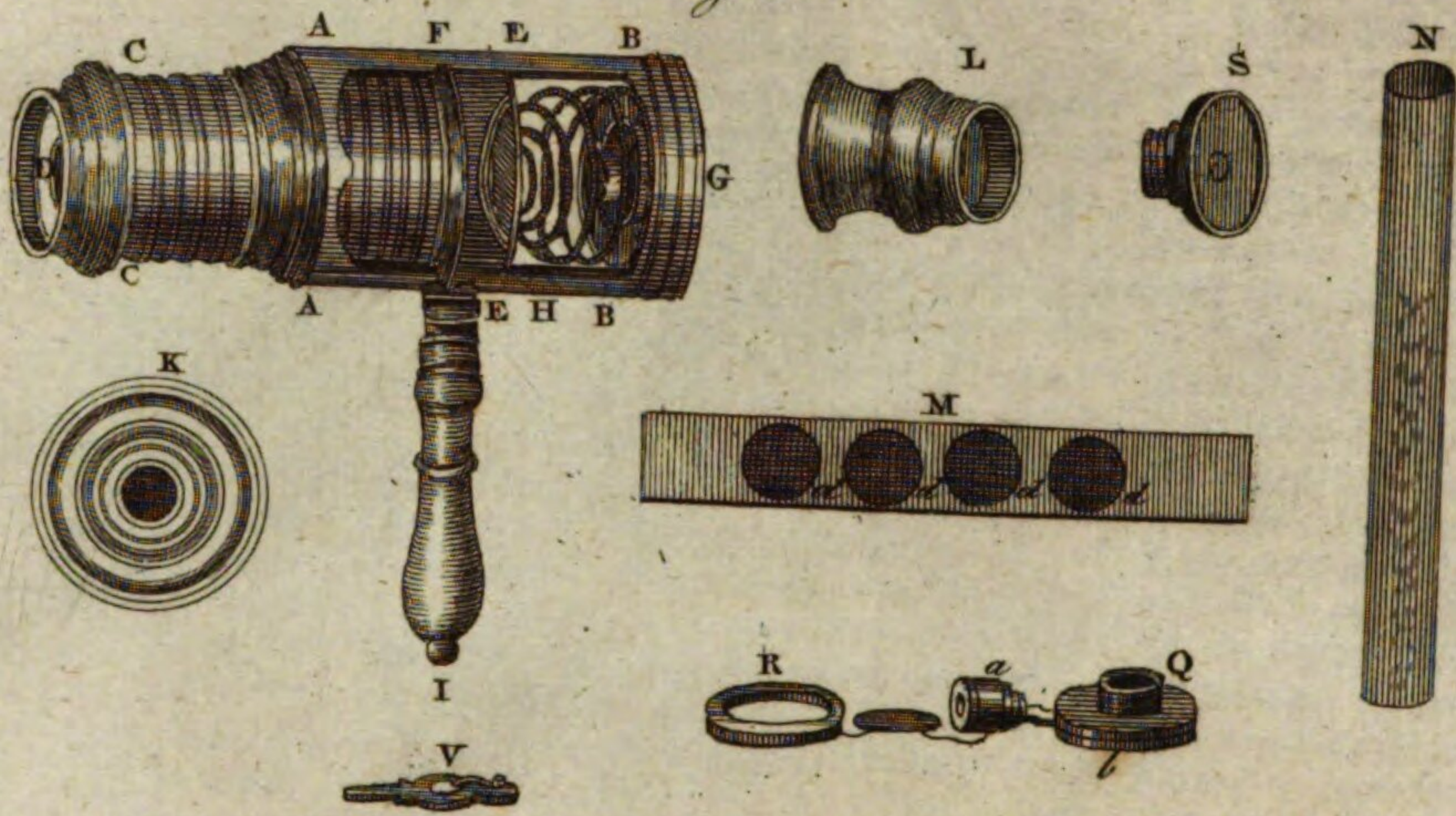


Fig. 2.

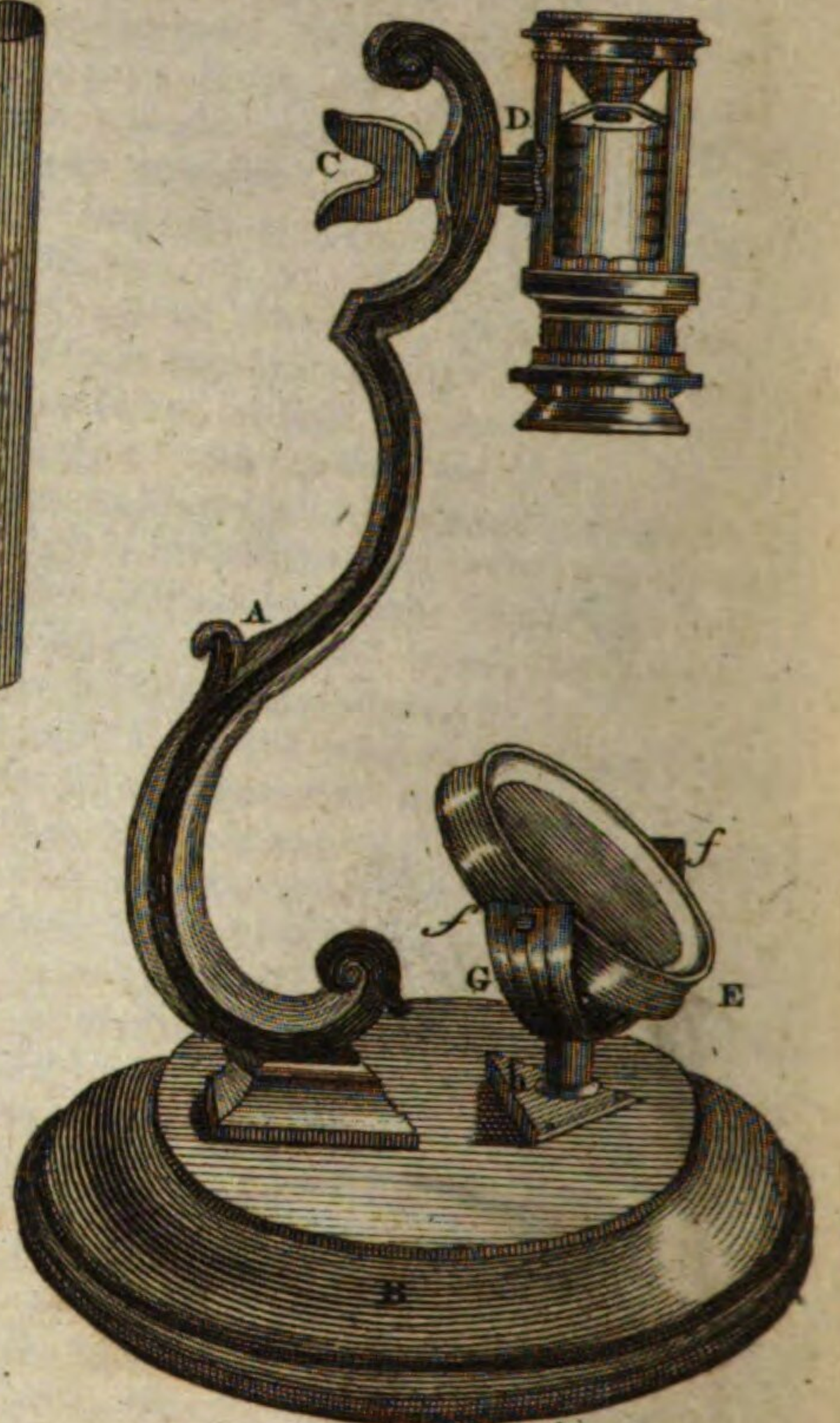


Fig. 7.

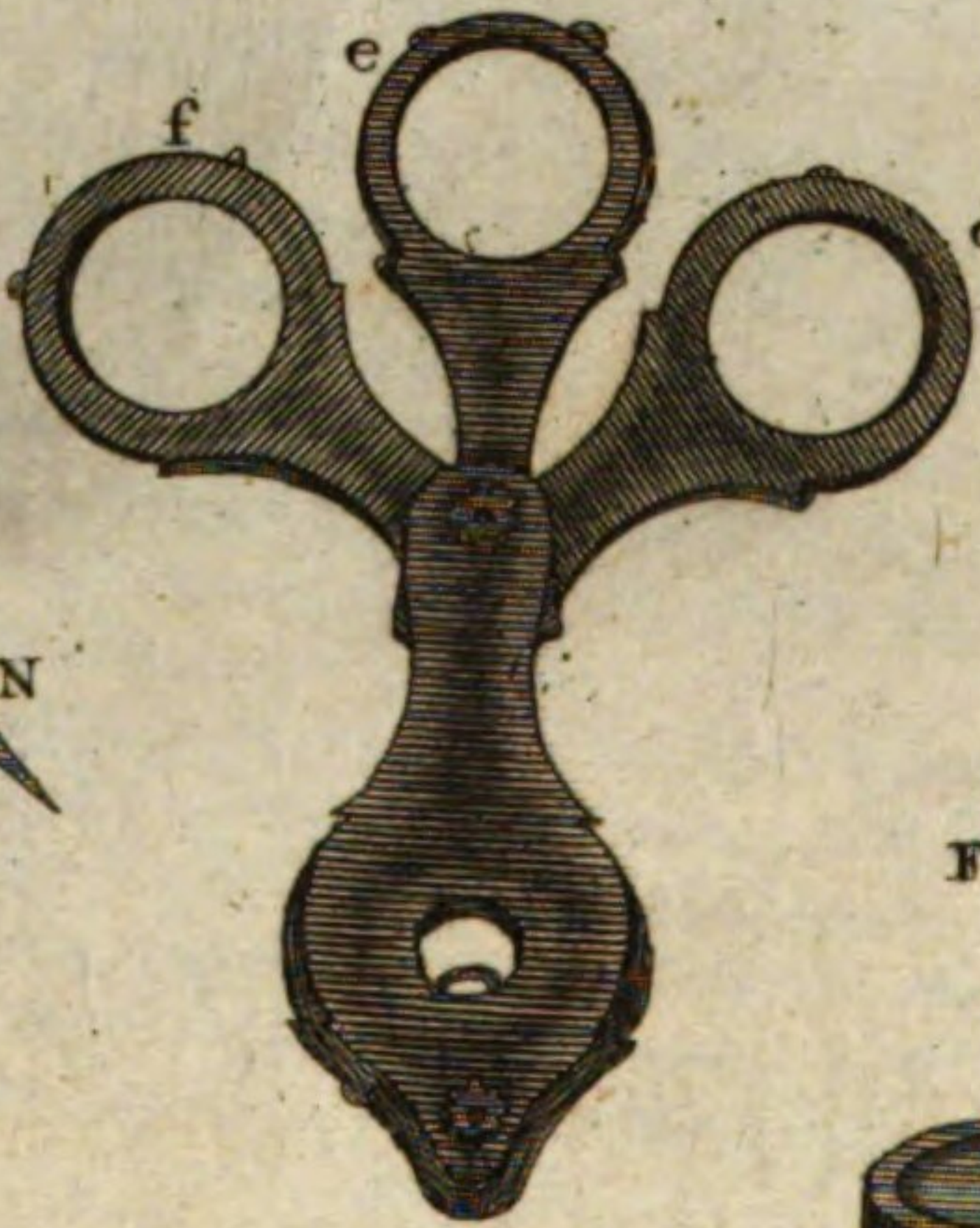


Fig. 3.



Fig. 4.

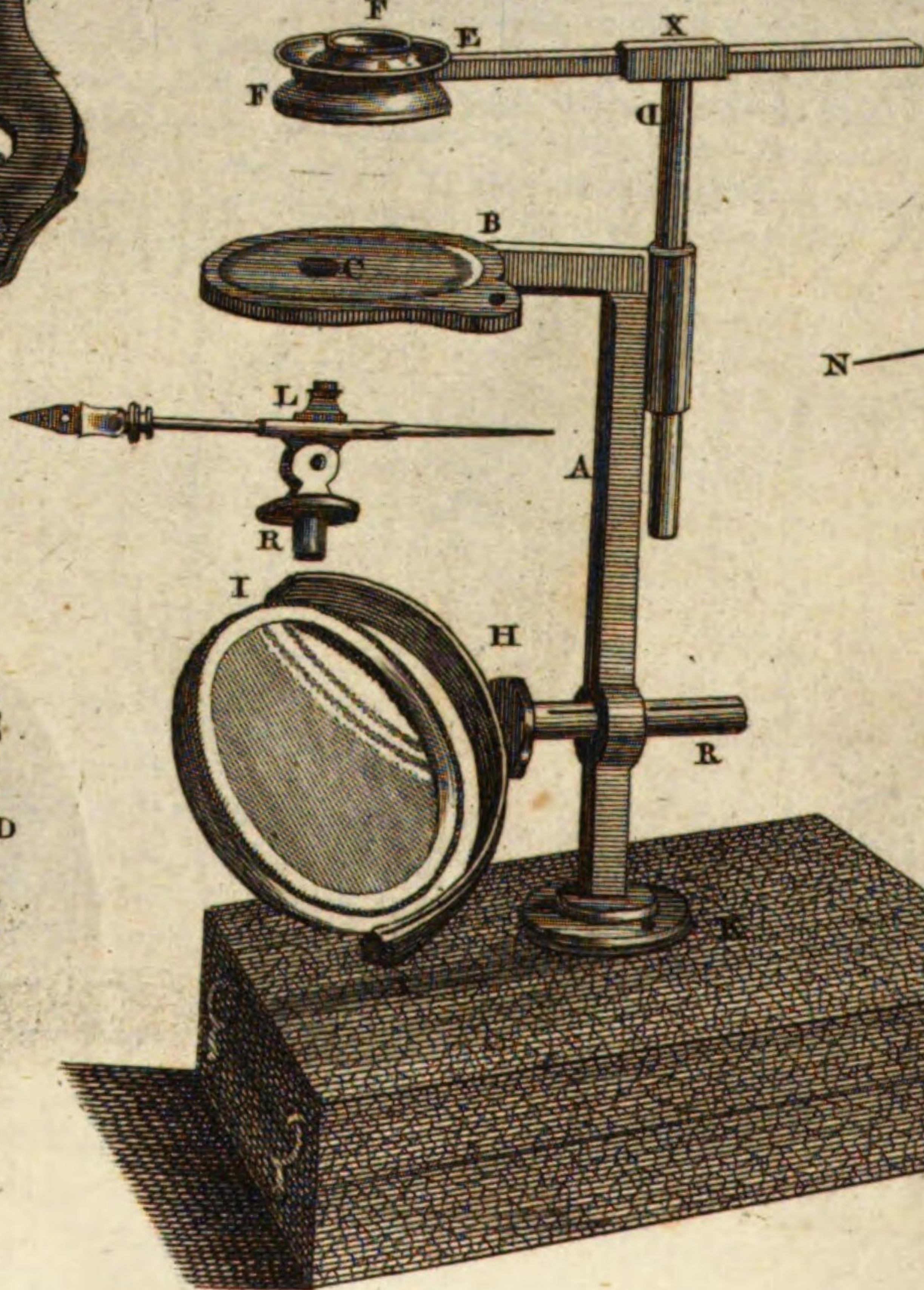


Fig. 5.

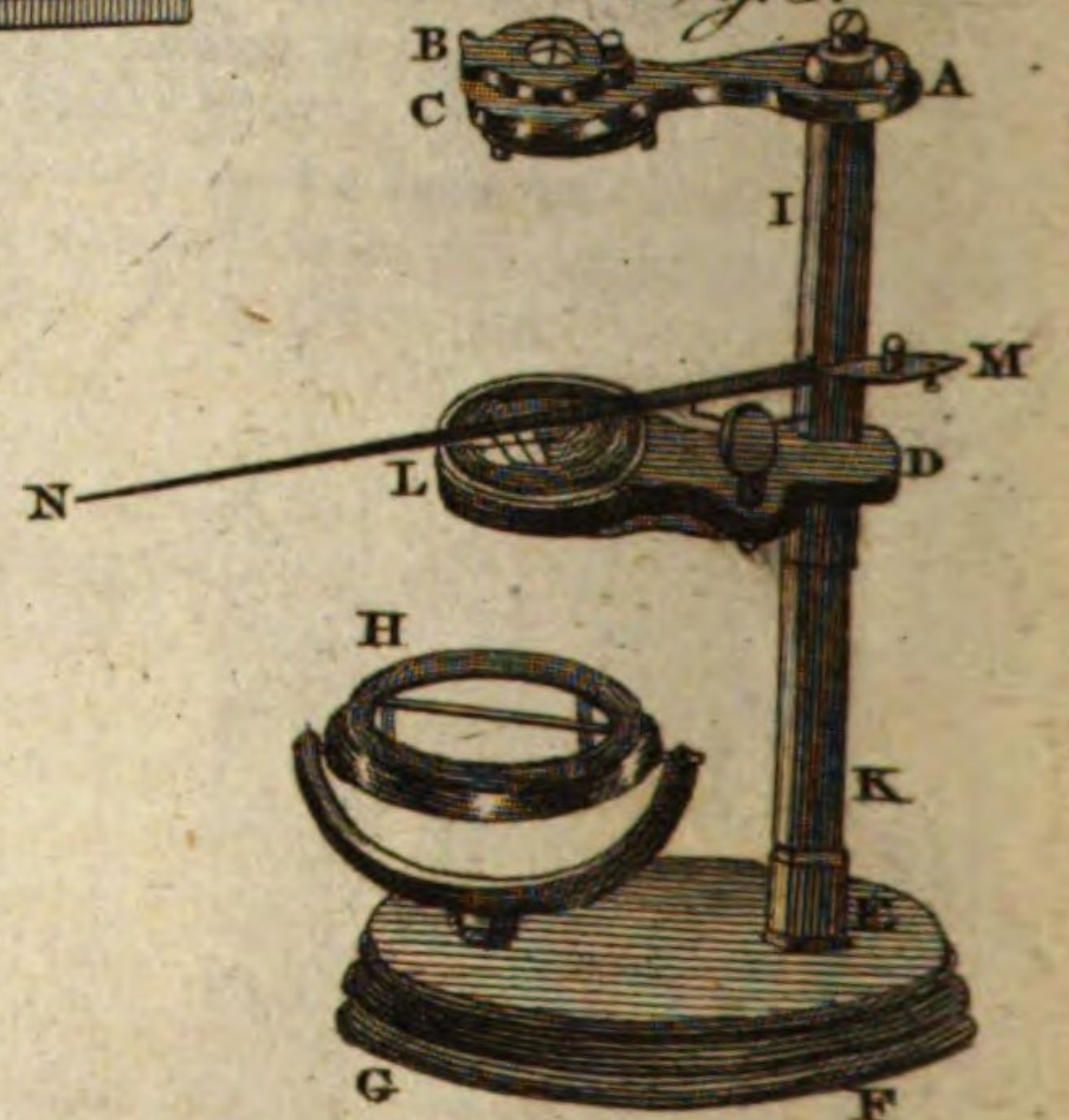
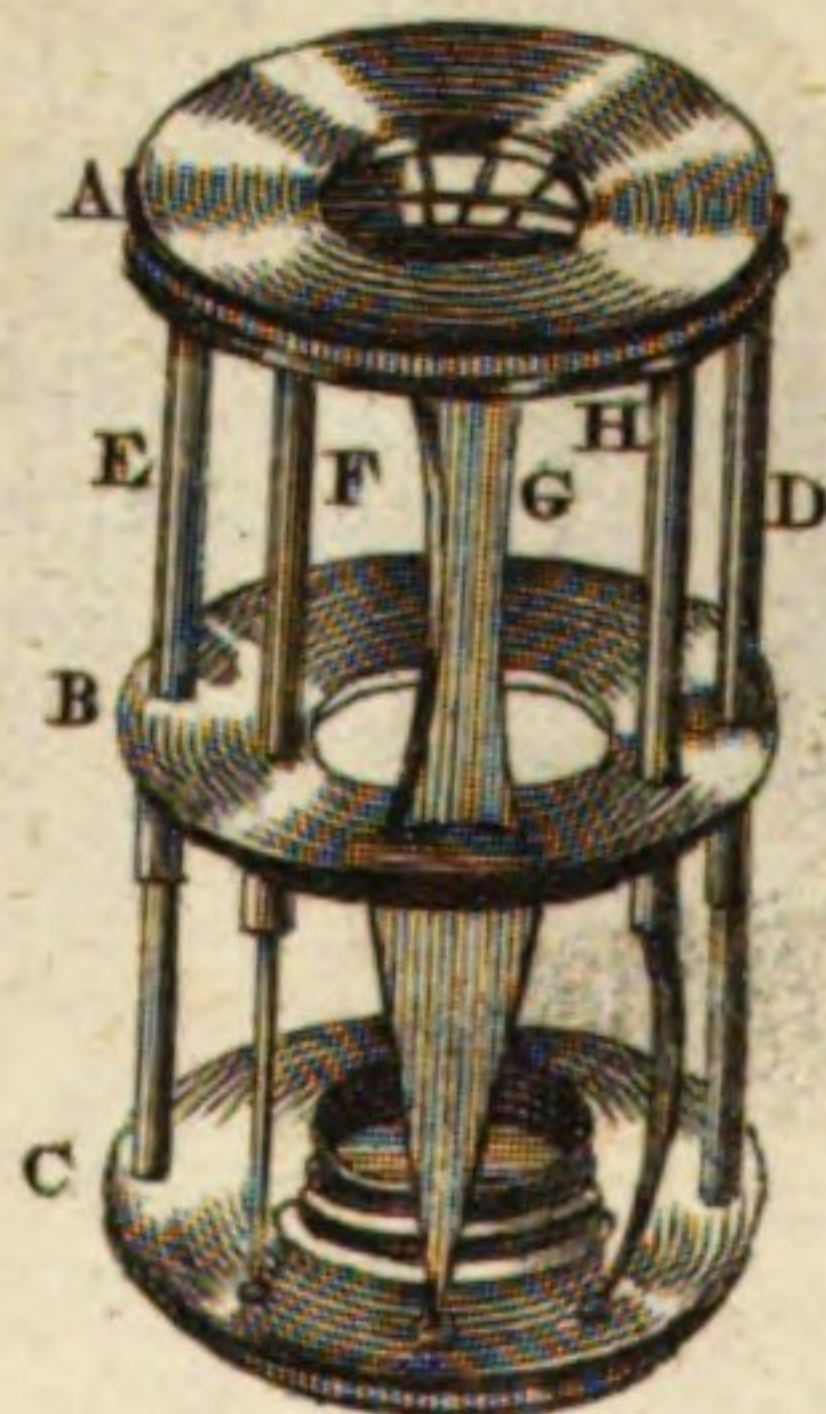


Fig. 6.



A. Bell Pin. Walsley for scut.

Micropus, now as 1000 squares in the length of an inch, multiplied by 1000, gives one million in an inch surface; by the same rule, one of those squares divided into 16 must be the sixteen millionth part of an inch surface. See fig. 26. which is a diminished view of the apparent surface exhibited under the magnifier n^o 1 of Wilson's microscope. In viewing the smallest lines, Mr Coventry uses n^o 2. or 3.; and they are all better seen, he says, by candle than by day-light.

MICROPUS, BASTARD CUDWEED: A genus of the polygamia necessaria order, belonging to the syngenesia class of plants; and in the natural method ranking under the 49th order, *Compositæ*. The receptacle is paleaceous; there is no pappus; the calyx is calyculated; there is no radius of the corolla. The female florets are wrapped in the scales of the calyx. There are two species, the *supinus* and *erectus*; but only the former is ever cultivated in gardens. It is an annual plant, growing naturally in Portugal, in places near the sea. The root sends out several trailing stalks, about six or eight inches long, which are garnished with small, oval, silvery leaves, whose bases embrace the stalks. The flowers come out in clusters from the wings of the stalks, and are very small, and of a white colour. It flowers in June and July; and is frequently preserved in gardens on account of the beauty of its silvery leaves. It is easily propagated by seed sown in autumn, and requires no other culture but to be kept free from weeds.

MICROSCOPE, an optical instrument, consisting of lenses, or mirrors, by means of which small objects appear larger than they do to the naked eye. *Single* microscopes consist of a single lens or mirror; or if more lenses or mirrors be made use of, they only serve to throw light upon the object, but do not contribute to enlarge the image of it. *Double* or *compound* microscopes are those in which the image of an object is composed by means of more lenses or mirrors than one.

For the principles on which the construction of microscopes depends, see *OPTICS*. In the present article, it is intended to describe the finished instrument, with all its varied apparatus, according to the latest improvements; and to illustrate by proper details its uses and importance.

I. Of SINGLE Microscopes.

THE famous microscopes made use of by Mr Leewenhoeck, were all, as Mr Baker assures us, of the single kind, and the construction of them was the most simple possible; each consisting only of a single lens set between two plates of silver, perforated with a small hole, with a moveable pin before it to place the object on and adjust it to the eye of the beholder. He informs us also, that *lenses* only, and not *globules*, were used in every one of these microscopes.

1. The single microscope now most generally known and used is that called *Wilson's Pocket Microscope*. The body is made of brass, ivory, or silver, and is represented by AA, BB. CC is a long fine-threaded male screw that turns into the body of the microscope; D a convex glass at the end of the screw. Two concave round pieces of thin brass, with holes of different diameters in the middle of them, are placed to cover the abovementioned glass, and thereby diminish the

aperture when the greatest magnifiers are employed. EE, three thin plates of brass within the body of the microscope; one of which is bent semicircularly in the middle, so as to form an arched cavity for the reception of a tube of glass, the use of the other two being to receive and hold the sliders between them. F, a piece of wood or ivory, arched in the manner of the semicircular plate, and cemented to it. G, the other end of the body of the microscope, where a hollow female screw is adapted to receive the different magnifiers. H, is a spiral spring of steel, between the end G and the plates of brass, intended to keep the plates in a right position and counteract the long screw CC. I, is a small turned handle, for the better holding of the instrument, to screw on or off at pleasure.

To this microscope belong six or seven magnifying glasses: six of them are set in silver, brass, or ivory, as in the figure K; and marked 1, 2, 3, 4, 5, 6, the lowest numbers being the greatest magnifiers. L is the seventh magnifier, set in the manner of a little barrel, to be held in the hand for the viewing of any larger object. M, is a flat slip of ivory, called a *slider*, with four round holes through it, wherein to place objects between two pieces of glass or Muscovy tale, as they appear at *dddd*. Six such sliders, and one of brass, are usually sold with this microscope, some with objects placed in them, and others empty for viewing any thing that may offer: but whoever pleases to make a collection, may have as many as he desires. The brass slider is to confine any small object, that it may be viewed without crushing or destroying it. N, is a tube of glass contrived to confine living objects, such as frogs, fishes, &c. in order to discover the circulation of the blood. All these are contained in a little neat box of fish-skin or mahogany, very convenient for carrying in the pocket.

When an object is to be viewed, thrust the ivory slider, in which the said object is placed, between the two flat brass plates EE: observing always to put that side of the slider where the brass rings are farthest from the eye. Then screw on the magnifying glass you intend to use, at the end of the instrument G; and looking through it against the light, turn the long screw CC, till your object be brought to suit your eye; which will be known by its appearing perfectly distinct and clear. It is most proper to look at it first through a magnifier that can show the whole at once, and afterwards to inspect the several parts more particularly with one of the greatest magnifiers; for thus you will gain a true idea of the whole, and of all its parts. And though the greatest magnifiers can show but a minute portion of any object at once, such as the claw of a flea, the horn of a louse, or the like; yet by gently moving the slider which contains the object, the eye will gradually examine it all over.

As objects must be brought very near the glasses when the greatest magnifiers are made use of, be careful not to scratch them by rubbing the slider against them as you move it in or out. A few turns of the screw CC will easily prevent this mischief, by giving them room enough. You may change the objects in your sliders for any others you think proper, by taking out the brass rings with the point of a penknife; the talcs will then fall out, if you but turn the sliders; and

Microscope and after putting what you please between them, by replacing the brass rings you will fasten them as they were before. It is proper to have some sliders furnished with talcs, but without any object between them, to be always in readiness for the examination of fluids, salts, sands, powders, the farina of flowers, or any other casual objects of such sort as need only be applied to the outside of the talc.

The circulation of the blood may be easiest seen in the tails or fins of fishes, in the fine membranes between a frog's toes, or best of all in the tail of a water-newt. If your object be a small fish, place it within the tube N, and spread its tail or fin along the side thereof: if a frog, choose such an one as can but just be got into your tube; and, with a pen, or small stick, expand the transparent membrane between the toes of the frog's hind foot as much as you can. When your object is so adjusted that no part of it can intercept the light from the place you intend to view, unscrew the long screw CC, and thrust your tube into the arched cavity, quite through the body of the microscope; then screw it to the true focal distance, and you will see the blood passing along its vessels with a rapid motion, and in a most surprising manner.

The third or fourth magnifiers may be used for frogs or fishes: but for the tails of water-newts, the fifth or sixth will do; because the globules of their blood are twice as large as those of frogs or fish. The first or second magnifier cannot well be employed for this purpose; because the thickness of the tube in which the object lies, will scarce admit its being brought so near as the focal distance of the magnifier.

An apparatus for the purpose of viewing opaque objects generally accompanies this microscope; and which consists of the following parts. A brass arm QR, which is screwed at Q, upon the body of the microscope at G. Into the round hole R, any of the magnifiers suitable to the object to be viewed are to be screwed; and under it, in the same ring, the concave polished silver speculum S. Through a small aperture in the body of the microscope under the brass plates EE, is to slide the long wire with the forceps T: This wire is pointed at one of its ends; and so, that either the points or forceps may be used for the objects as may be necessary. It is easy to conceive, therefore, that the arm at R, which turns by a twofold joint at *a* and *b*, may be brought with its magnifier over the object, the light reflected upon it by the application of the speculum, and the true focus obtained by turning of the male screw CC as before directed.—As objects are sometimes not well fixed for view, either by the forceps or point, the small piece shown at N is added, and in such cases answers better: it screws over the point of T; it contains a small round piece of ivory, blackened on one side, and left white upon the other as a contrast to coloured objects, and by a small piece of watch-spring fastens down the objects upon the ivory.

2. *Single Microscope by reflection.* In fig. 2. A is a scroll of brass fixed upright upon a round wooden base B, or mahogany drawer or case, so as to stand perfectly firm and steady. C is a brass screw, that passes through a hole in the upper limb of the scroll into the side of the microscope D, and screws it fast to the said scroll. E is a concave speculum set in a

box of brass, which hangs in the arch G by two small screws *ff*, that screw into the opposite sides thereof. At the bottom of this arch is a pin of the same metal, exactly fitted to a hole *h* in the wooden pedestal, made for the reception of the pin. As the arch turns on this pin, and the speculum turns on the end of the arch, it may, by this twofold motion, be easily adjusted in such a manner as to reflect the light of the sun, of the sky, or of a candle, directly upwards through the microscope that is fixed perpendicularly over it; and by so doing may be made to answer many purposes of the large double reflecting microscope. The body of the microscope may also be fixed horizontally, and objects viewed in that position by any light you choose; which is an advantage the common double reflecting microscope has not. It may also be rendered further useful by means of a slip of glass; one end of which being thrust through between the plates where the sliders go, and the other extending to some distance, such objects may be placed thereon as cannot be applied in the sliders: and then, having a limb of brass that may fasten to the body of the microscope, and extend over the projecting glass a hollow ring wherein to screw the magnifiers, all sorts of subjects may be examined with great convenience, if a hole be made in the pedestal, to place the speculum exactly underneath, and thereby throw up the rays of light. The pocket-microscope, thus mounted, says Mr Baker, "is as easy and pleasant in its use; as fit for the most curious examination of the animalcules and salts in fluids, of the farinæ in vegetables, and of the circulation in small animals; in short, is as likely to make considerable discoveries in objects that have some degree of transparency, as any microscope I have ever seen or heard of."

The brass scroll A is now generally made to unscrew into three parts, and pack with the microscope and apparatus into the drawer of a mahogany pocket-case, upon the lid of which the scroll is made to fix when in use.

The opaque apparatus also, as above described, is applicable this way by reflection. It only consists in turning the arm R (fig. 1.), with the magnifier over the concave speculum below (fig. 2), or to receive the light as reflected obliquely from it: the silver speculum screwed into R will then reflect the light, which it receives from the glass speculum, strongly upon the object that is applied upon the wire T underneath.

This microscope, however, is not upon the most convenient construction, in comparison with others now made: it has been esteemed for many years past from its popular name, and recommendation by its makers. Its portability is certainly a great advantage in its favour; but in most respects it is superseded by the microscopes hereafter described.

3. *Microscope for Opaque Objects, called the Single Opaque Microscope.* This microscope remedies the inconvenience of having the dark side of an object next the eye, which formerly was an unsurmountable objection to the making observations on opaque objects with any considerable degree of exactness or satisfaction: for, in all other contrivances commonly known, the nearness of the instrument to the object (when glasses that magnify much are used) unavoidably overshadows it so much, that its appearance is rendered obscure and indistinct. And, notwithstanding ways have

Microscope have been tried to point light upon an object, from the sun or a candle, by a convex glass placed on the side thereof, the rays from either can be thrown upon it in such an acute angle only, that they serve to give a confused glare, but are insufficient to afford a clear and perfect view of the object. But this microscope, by means of a concave speculum of silver highly polished, in whose centre a magnifying lens is placed, such a strong and direct light is reflected upon the object, that it may be examined with all imaginable ease and pleasure. The several parts of this instrument, made either of brass or silver, are as follow.

Through the first side A, passes a fine screw B, the other end of which is fastened to the moveable side C. D is a nut applied to this screw, by the turning of which the two sides A and C are gradually brought together. E is a spring of steel that separates the two sides when the nut is unscrewed. F is a piece of brass, turning round in a socket, whence proceeds a small spring tube moving upon a rivet; through which tube there runs a steel wire, one end whereof terminates in a sharp point G, and the other with a pair of pliers H fastened to it. The point and pliers are to thrust into, or take up and hold, any insect or object; and either of them may be turned upwards, as best suits the purpose. I is a ring of brass, with a female screw within it, mounted on an upright piece of the same metal; which turns round on a rivet, that it may be set at a due distance when the least magnifiers are employed. This ring receives the screws of all the magnifiers. K is a concave speculum of silver, polished as bright as possible; in the centre of which is placed a double convex lens, with a proper aperture to look through it. On the back of this speculum a male screw L is made to fit the brass ring I, to screw into it at pleasure. There are four of these concave specula of different depths, adapted to four glasses of different magnifying powers, to be used as the objects to be examined may require. The greatest magnifiers have the least apertures. M, is a round object-plate, one side of which is white and the other black: The intention of this is to render objects the more visible, by placing them, if black, on the white side, or, if white, on the black side. A steel spring N turns down on each side to make any object fast; and issuing from the object-plate is a hollow pipe to screw it on the needle's point G. O, is a small box of brass, with a glass on each side, contrived to confine any living object, in order to examine it: this also has a pipe to screw upon the end of the needle G. P, is a turned handle of wood, to screw into the instrument when it is made use of. Q, a pair of brass pliers to take up any object, or manage it with convenience. R, is a soft hair-brush for cleaning the glasses, &c. S, is a small ivory box for talcs, to be placed, when wanted, in the small brass-box O.

When you would view any object with this microscope, screw the speculum, with the magnifier you think proper to use, into the brass ring I. Place your object, either on the needle G in the pliers H, on the object-plate M, or in the hollow brass box O, as may be most convenient. then holding up your instrument by the handle P, look against the light through the magnifying lens; and by means of the nut D, together with the motion of the needle, by managing its lower

end, the object may be turned about, raised, or depressed, brought nearer the glass, or removed farther from it, till you find the true focal distance, and the light be seen strongly reflected from the speculum upon the object, by which means it will be shown in a manner surprisingly distinct and clear; and for this purpose the light of the sky or of a candle will answer very well. Transparent objects may also be viewed by this microscope; only observing, that when such come under examination, it will not always be proper to throw on them the light reflected from the speculum; for the light transmitted through them, meeting the reflected light, may together produce too great a glare. A little practice, however, will show how to regulate both lights in a proper manner.

4. *Ellis's single and Aquatic Microscope.* Fig. 4. represents a very convenient and useful microscope, contrived by Mr John Ellis, author of An Essay upon Corallines, &c. To practical botanists, observers of animalcula, &c. it possesses many advantages above those just described. It is portable, simple in its construction, expeditious, and commodious in use. K, represents the box containing the whole apparatus: it is generally made of fish-skin; and on the top there is a female screw, for receiving the screw that is at the bottom of the pillar A: this is a pillar of brass, and is screwed on the top of the box. D, is a brass pin which fits into the pillar; on the top of this pin is a hollow socket to receive the arm which carries the magnifiers; the pin is to be moved up and down, in order to adjust the lenses to their focal or proper distance from the object. [N. B. In the representations of this microscope, the pin D is delineated as passing through a socket at one side of the pillar A; whereas it is usual at present to make it pass down a hole bored through the middle of the pillar.] E, the bar which carries the magnifying lens; it fits into the socket X, which is at the top of the pin or pillar D. This arm may be moved backwards and forwards in the socket X, and sideways by the pin D; so that the magnifier, which is screwed into the ring at the end E of this bar, may be easily made to traverse over any part of the object that lies on the stage or plate B. FF is a polished silver speculum, with a magnifying lens placed at the centre thereof, which is perforated for this purpose. The silver speculum screws into the arm E, as at F. G, another speculum, with its lens, which is of a different magnifying power from the former. H, the semicircle which supports the mirror I; the pin R, affixed to the semicircle H, passes thro' the hole which is towards the bottom of the pillar A. B, the stage, or the plane, on which the objects are to be placed; it fits into the small dove-tailed arm which is at the upper end of the pillar DA. C, a plane glass, with a small piece of black silk stuck on it; this glass is to lay in a groove made in the stage B. M, a hollow glass to be laid occasionally on the stage instead of the plane glass C. L, a pair of nippers. These are fixed to the stage by the pin at bottom; the steel wire of these nippers slides backwards and forwards in the socket, and this socket is moveable upwards and downwards by means of the joint, so that the position of the object may be varied at pleasure. The object may be fixed in the nippers, stuck on the point, or affixed, by a little gum-water, &c. to the

ivory

Microscope ivory cylinder N, which occasionally screws to the point of the nippers.

To *use* this microscope: Take all the parts of the apparatus out of the box; then begin by screwing the pillar A to the cover thereof; pass the pin R of the semicircle which carries the mirror thro' the hole that is near the bottom of the pillar A; push the stage into the dove-tail at B, slide the pin into the pillar (see the N. B. above); then pass the bar E through the socket which is at the top of the pin D, and screw one of the magnifying lenses into the ring at F. The microscope is now ready for use: and though the enumeration of the articles may lead the reader to imagine the instrument to be of a complex nature, we can safely affirm that he will find it otherwise. The instrument has this peculiar advantage, that it is difficult to put any of the pieces in a place which is appropriated to another. Let the object be now placed either on the stage or in the nippers L, and in such manner that it may be as nearly as possible over the centre of the stage: bring the speculum F over the part you mean to observe; then throw as much light on the speculum as you can, by means of the mirror I, and the double motion of which it is capable; the light received on the speculum is reflected by it on the object. The distance of the lens F from the object is regulated by moving the pin D up and down, until a distinct view of it is obtained. The best rule is, to place the lens beyond its focal distance from the object, and then gradually to slide it down till the object appears sharp and well defined. The adjustment of the lenses to their focus, and the distribution of the light on the object, are what require the most attention: on the first the distinctness of the vision depends; the pleasure arising from a clear view of the parts under observation is due to the modification of the light. No precise rule can be given for attaining accurately these points; it is from practice alone that ready habits of obtaining these necessary properties can be acquired, and with the assistance of this no difficulty will be found.

5. A very simple and convenient microscope for botanical and other purposes, though inferior in many respects to that of Mr Ellis, was contrived by the late ingenious Mr Benjamin Martin, and is represented at fig. 5. where AB represents a small arm supporting two or more magnifiers, one fixed to the upper part as at B, the other to the lower part of the arm at C; these may be used separately or combined together. The arm AB is supported by the square pillar IK, the lower end of which fits into the socket E of the foot FG; the stage DL is made to slide up and down the square pillar; H, a concave mirror for reflecting light on the object.—To *use* this microscope, place the object on the stage, reflect the light on it from the concave mirror, and regulate it to the focus, by moving the stage nearer to or farther from the lens at B. The ivory sliders pass through the stage; other objects may be fixed in the nippers MN, and then brought under the eye-glasses; or they may be laid on one of the glasses which fit the stage. The apparatus to this instrument consists of three ivory sliders; a pair of nippers; a pair of forceps; a flat glass and a concave ditto, both fitted to the stage.

The two last microscopes are frequently fitted up
N^o 118.

with a toothed rack and pinion, for the more ready *Microscope* adjustment of the glasses to their proper focus.

6. *Withering's portable Botanic Microscope*. Fig. 6. represents a small botanical microscope contrived by Dr Withering, and described by him in his *Botanical Arrangements*. It consists of three brass plates, A, B, C, which are parallel to each other; the wires D and E are rivetted into the upper and lower plates, which are by this means united to each other; the middle plate or stage is moveable on the aforesaid wires by two little sockets which are fixed to it. The two upper plates each contain a magnifying lens, but of different powers; one of these confines and keeps in their places the fine point F, the forceps G, and the small knife H.—To *use* this instrument, unscrew the upper lens, and take out the point, the knife, and the forceps; then screw the lens on again, place the object on the stage, and then move it up or down till you have gained a distinct view of the object, as one lens is made of a shorter focus than the other; and spare lenses of a still deeper focus may be had if required. This little microscope is the most portable of any. Its principal merit is its simplicity.

7. *Botanical Lenses or Magnifiers*. The haste with which botanists, &c. have frequently occasion to view objects, renders an extempore pocket-glass indispensably necessary. The most convenient of any yet constructed, appears to be that contrived, in regard to the form of the mounting, by the late Mr Benjamin Martin; and is what he called a *Hand Megaloscope*, because it is well adapted for viewing all the larger sort of small objects universally, and by only three lenses it has seven different magnifying powers.

Fig. 7. represents the case with the three frames and lenses, which are usually of 1, 1½, and 2 inches focus: they all turn over each other, and shut into the case, and are turned out at pleasure.

The three lenses singly, afford three magnifying powers; and by combining two and two, we make three more: for *d* with *e* makes one, *d* with *f* another, and *e* with *f* a third; which, with the three singly, make six; and lastly, all three combined together make another; so that upon the whole, there are seven powers of magnifying with these glasses only.

When the three lenses are combined, it is better to turn them in, and look through them by the small apertures in the sides of the case. The eye in this case is excluded from extra light; the aberration of the superfluous rays through the glasses is cut off; and the eye coincides more exactly with the common axes of the lenses.

A very useful and easy kind of microscope (described by Joblot, and which has been long in use), adapted chiefly for viewing, and confining at the same time, any living insects, small animals, &c. is shown at fig. 8. where A represents a glass tube, about 1½ inches diameter, and 2 inches high. B, a case of brass or wood, containing a sliding tube, with two or three magnifying glasses that may be used either separately or combined. In the inside, at the bottom, is a piece of ivory, black and white on opposite sides, that is occasionally removed, and admits a point to be screwed into the centre. The cap unscrews at D, to admit the placing of the object: the proper distance of the glasses

from

M I C R O S C O P E .

Plate CCXCVIII.

Fig. 8.

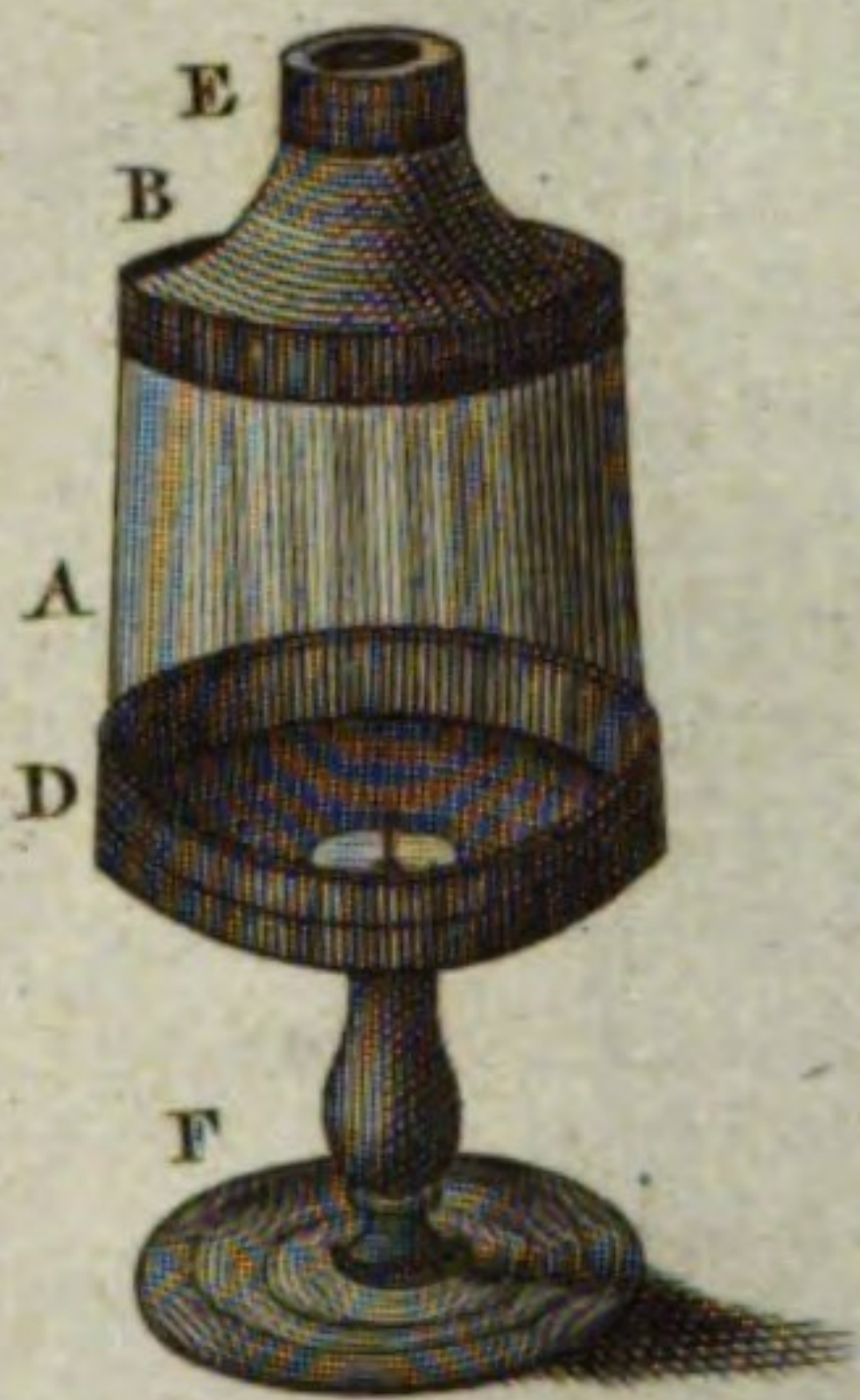


Fig. 9.

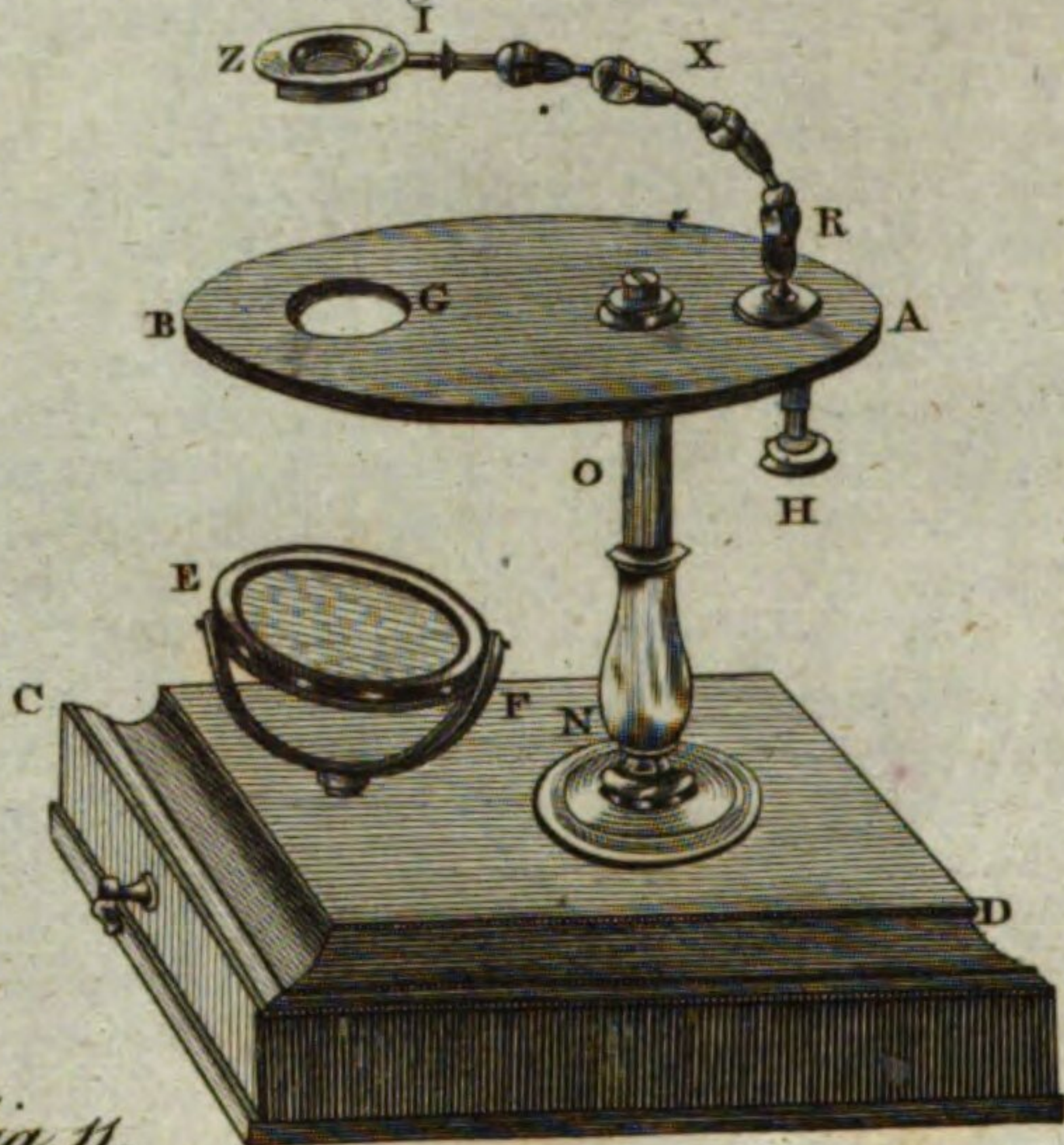


Fig. 11.

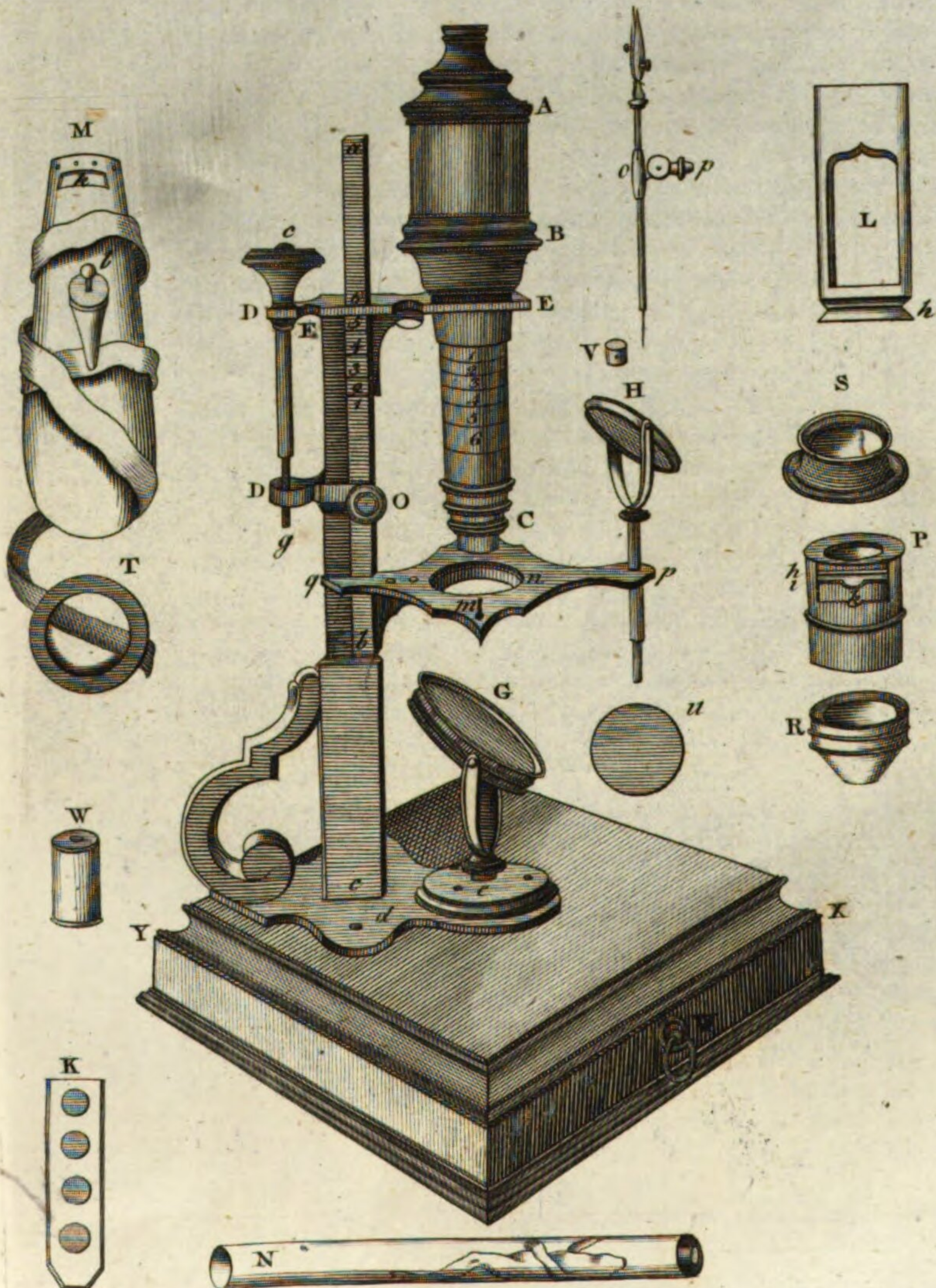


Fig. 10.

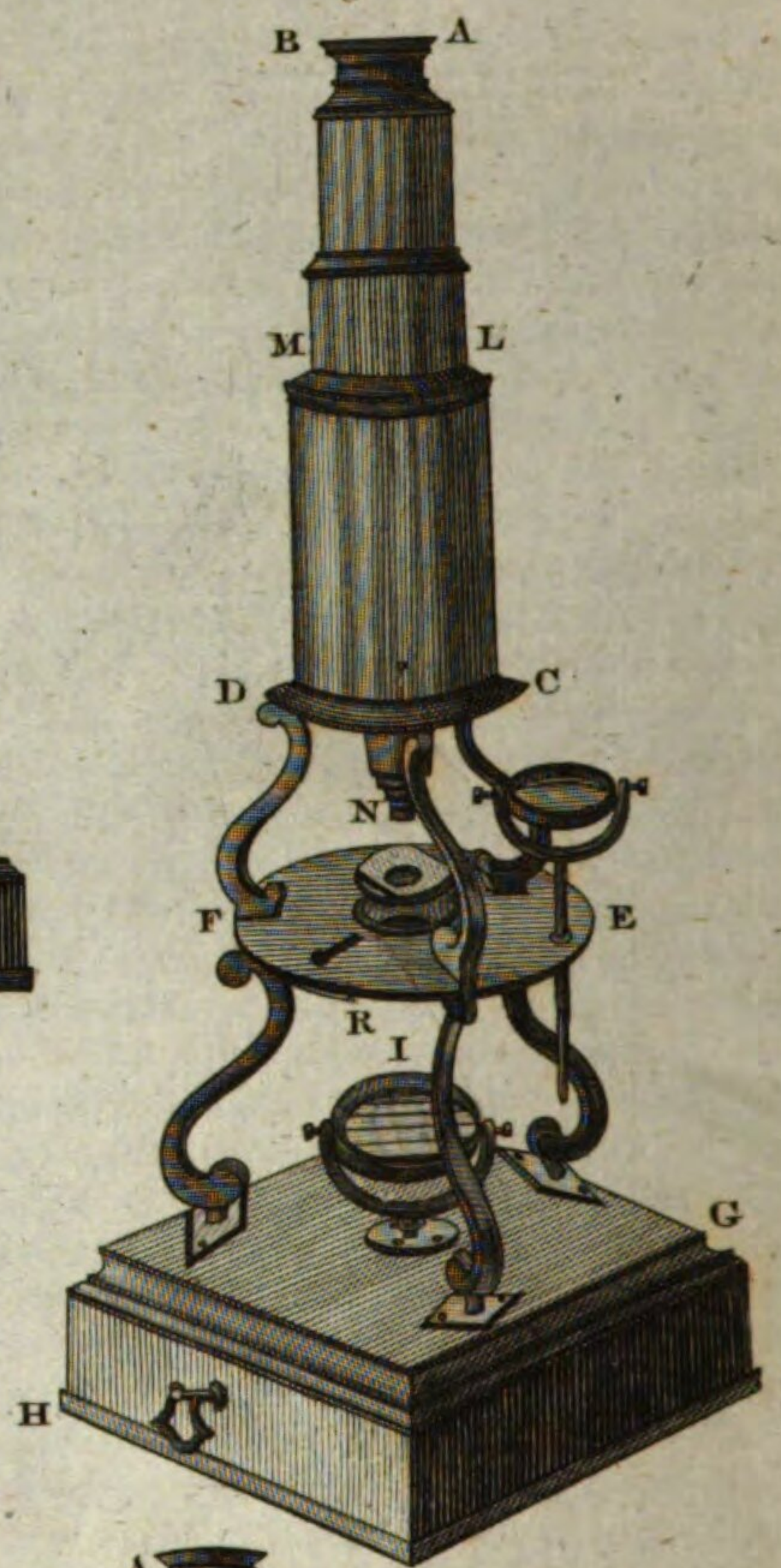
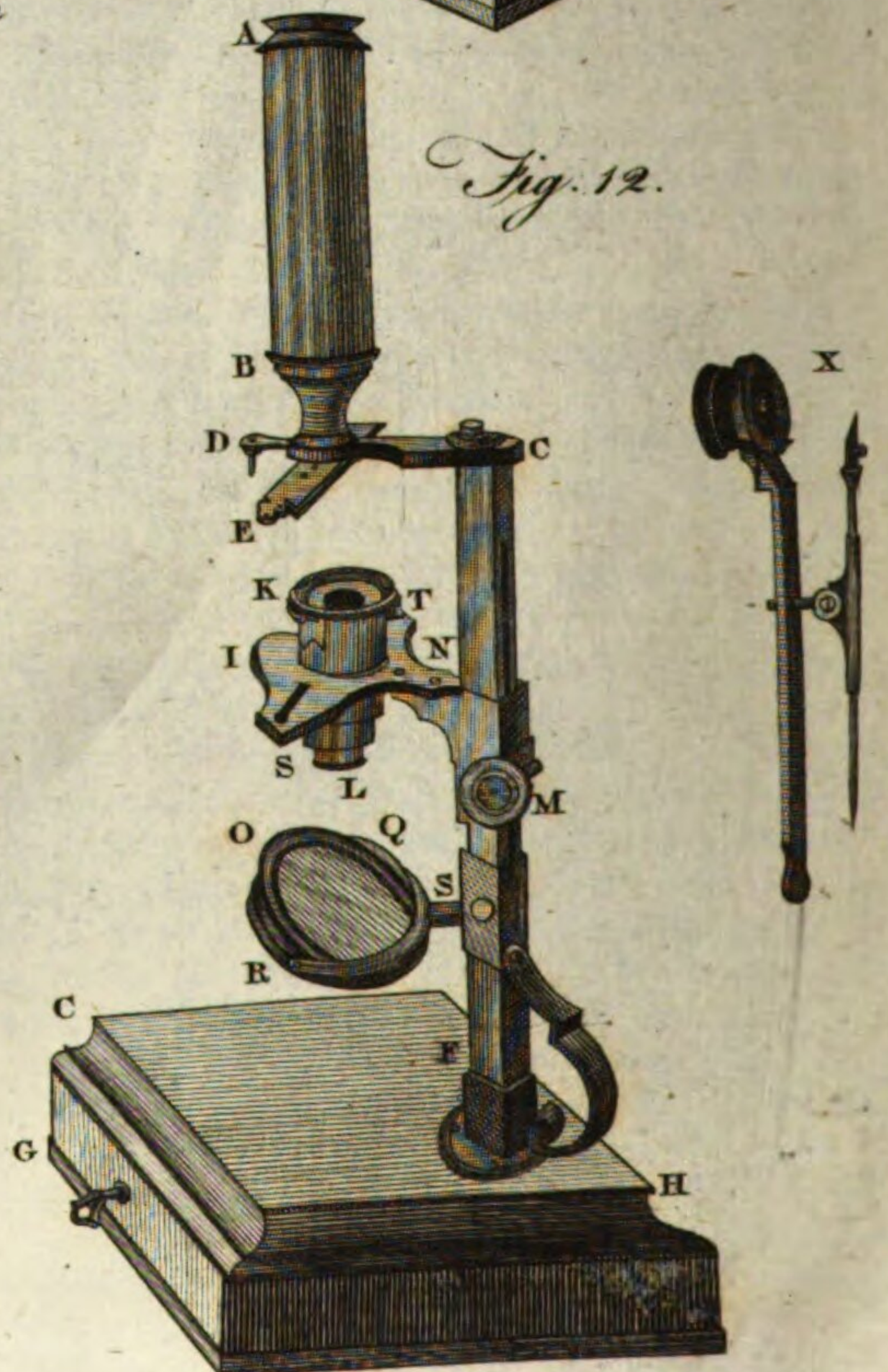


Fig. 12.



A. Bell Prin. W. A. Sculptor fecit.

Microscope from the object is regulated by pulling up or down the brass tube E at top containing the eye-glasses.

This microscope is particularly useful for exhibiting the well-known curious *curculio imperialis*, vulgarly called the *diamond beetle*, to the greatest advantage; for which, as well as for other objects, a glass bottom, and a polished reflector at the top, are often applied, to condense the light upon the object. In this case, the stand and brass-bottom F, as shown in the figure, are taken away by unscrewing.

9. *Mr Lyonet's Single Anatomical Dissecting Microscope.* Fig. 9. represents a curious and extremely useful microscope, invented by that gentleman for the purpose of minute dissections, and microscopic preparations. This instrument must be truly useful to amateurs of the minutiae of insects, &c. being the best adapted of any for the purposes of dissection. With this instrument Mr Lyonet made his very curious microscopical dissection of the *chenille de saule*, as related in his *Traité Anatomique de la chenille qui ronge le bois de saule*, 4to.

AB is the anatomical table, which is supported by a pillar NO; this is screwed on the foot CD. The table AB is prevented from turning round by means of two steady pins. In this table or board there is a hole G, which is exactly over the centre of the mirror EF, that is to reflect the light on the object; the hole G is designed to receive a flat or concave glass, on which the objects for examination are to be placed.

RXZ is an arm formed of several balls and sockets, by which means it may be moved in every possible situation; it is fixed to the board by means of the screw H. The last arm IZ has a female screw, into which a magnifier may be screwed as at Z. By means of the screw H, a small motion may be occasionally given to the arm IZ, for adjusting the lens with accuracy to its focal distance from the object.

Another chain of balls is sometimes used, carrying a lens to throw light upon the object; the mirror is likewise so mounted, as to be taken from its place at K, and fitted on a clamp, by which it may be fixed to any part of the table AB.

To use the Dissecting Table:—Let the operator sit with his left side near a light window; the instrument being placed on a firm table, the side DH towards the stomach, the observations should be made with the left eye. In dissecting, the two elbows are to be supported by the table on which the instrument rests, the hands resting against the board AB; and in order to give it greater stability (as a small shake, though imperceptible to the naked eye, is very visible in the microscope), the dissecting instruments are to be held one in each hand, between the thumb and two fore-fingers.

11. Of DOUBLE Microscopes, commonly called COMPOUND Microscopes.

Double microscopes are so called, from being a combination of two or more lenses.

The particular and chief advantages which the compound microscopes have over the single, are, that the objects are represented under a larger field of view, and with a greater amplification of reflected light.

1. *Culpeper's Microscope.* The compound microscope, originally contrived by Mr Culpeper, is represented at Vol. XI. Part II.

fig. 10. It consists of a large external brass body A, Microscope B, C, D, supported upon three scrolls, which are fixed to the stage EF; the stage is supported by three larger scrolls, that are screwed to the mahogany pedestal GH. There is a drawer in the pedestal, which holds the apparatus. The concave mirror I is fitted to a socket in the centre of the pedestal. The lower part LMCD of the body forms an exterior tube, into which the upper part of the body ABLM slides, and may be moved up or down, so as to bring the magnifiers, which are screwed on at N, nearer to or farther from the object.

To use this microscope: Screw one of the buttons, which contains a magnifying lens, to the end N of the body; place the slider, with the objects, between the plates of the slider-holder. Then, to attain distinct vision, and a pleasing view of the object, adjust the body to the focus of the lens you are using, by moving the upper part gently up and down, and regulate the light by the concave mirror.

For opaque objects, two additional pieces must be used. The first is a cylindrical tube of brass (represented at L, fig. 11.), which fits on the cylindrical part at N of the body. The second piece is the concave speculum b; this is to be screwed to the lower end of the aforesaid tube: the upper edge of this tube should be made to coincide with the line which has the same number affixed to it as to the magnifier you are using; *ex. gr.* if you are making use of the magnifier marked 5, slide the tube to the circular line on the tube N that is marked also with N° 5. The slider-holder should be removed when you are going to view opaque objects, and a plane glass should be placed on the stage in its stead to receive the object; or it may be placed in the nippers, the pin of which fits into the hole in the stage.

The apparatus belonging to this microscope consists of the following particulars; *viz.* Five magnifiers, each fitted in a brass button; one of these is seen at N, fig. 10. Six ivory sliders, five of them with objects. A brass tube, to hold the concave speculum. The concave speculum in a brass box. A fish pan. A set of glass tubes. A flat glass fitted to the stage. A concave glass fitted to the stage. A pair of forceps. A steel wire, with a pair of nippers at one end and a point at the other. A small ivory cylinder, to fit on the pointed end of the aforesaid nippers. A convex lens, moveable in a brass semicircle; this is affixed to a long brass pin, which fits into a hole on the stage.

The construction of the foregoing microscope is very simple, and it is easy in use; but the advantages of the stage and mirror are too much confined for an extensive application and management of all kinds of objects. Its greatest recommendation is its cheapness; and to those who are desirous of having a compound microscope at a low price, it may be acceptable.

2. *Cuff's Microscope.* The improved microscope next in order is that of Mr Cuff. Besides remedying the disadvantages above mentioned, it contains the addition of an adjusting screw, which is a considerable improvement, and highly necessary to the examination of objects under the best defined appearance from the glasses. It is represented at fig. 11. with the apparatus that usually accompanies it. A, B, C, shows the body of this microscope; which contains an eye-glass at A, a broad lens at B, and

Microscope a magnifier which is screwed on at C. The body is supported by the arm D E, from which it may be removed at pleasure. The arm D E is fixed on the sliding-bar F, and may be raised or depressed to any height within its limits. The main pillar *ab* is fixed in the box *be*; and by means of the brass foot *d* is screwed to the mahogany pedestal X Y, in which is a drawer containing all the apparatus. O, is a milled-headed screw, to tighten the bar F when the adjusting screw *cg* is used. *pq* Is the stage, or plate, which carries the objects; it has a hole at the centre *n*. G a concave mirror, that may be turned in any direction, to reflect the light of a candle, or the sky, upon the object.

To use this microscope: Screw the magnifier you intend to use to the end C of the body, place the slider-holder P in the hole *n*, and the slider with the object between the plates of the slider-holder; set the upper edge of the bar D E to coincide with the divisions which correspond to the magnifier you have in use, and pinch it by the milled nut; now reflect a proper quantity of light upon the object, by means of the concave mirror G, and regulate the body exactly to the eye and the focus of the glasses by the adjusting screw *cg*.

To view *opaque* objects, take away the slider-holder P, and place the object on a flat glass under the centre of the body, or on one end of the jointed nippers *op*. Then screw the silver concave speculum *b* to the end of the cylinder L, and slide this cylinder on the lower part of the body, so that the upper edge thereof may coincide with the line which has the same mark with the magnifier that is then used; reflect the light from the concave mirror G to the silver speculum, from which it will again be reflected on the object. The glasses are to be adjusted to their focal distance as before directed.

The apparatus consists of a convex lens H, to collect the rays of light from the sun or a candle, and condense them on the object. L a cylindrical tube, open at each side, with a concave speculum screwed to the lower end *b*. P the slider-holder: this consists of a cylindrical tube, in which an inner tube is forced upwards by a spiral spring; it is used to receive an ivory slider K, which is to be slid between the plates *b* and *i*. The cylinder P fits the hole *n* in the stage; and the hollow part at *k* is designed to receive a glass tube. R is a brass cone, to be put under the bottom of the cylinder P, to intercept occasionally some of the rays of light. S a box containing a concave and a flat glass, between which a small living insect may be confined: it is to be placed over the hole *n*. T a flat glass, to lay any occasional object upon; there is also a concave one for fluids. O is a long steel wire, with a small pair of pliers at one end, and a point at the other, designed to stick or hold objects; it slips backwards and forwards in the short tube *o*; the pin *p* fits into the hole of the stage. W a little round ivory box, to hold a supply of talc and rings for the sliders. V a small ivory cylinder, that fits on the pointed end of the steel wire: it is designed for opaque objects. Light-coloured ones are to be stuck upon the dark side, and *vice versa*. M a fish-pan, whereon to fasten a small fish, to view the circulation of the blood: the tail is to be spread across the oblong hole

k at the small end, and tied fast, by means of a rib. Microscope band fixed thereto; the knob *i* is to be shoved through the slit made in the stage, that the tail may be brought under the magnifier.

3. This microscope has received several material improvements from Mr Martin, Mr Adams, &c. By an alteration, or rather an enlargement, of the body of the tube which contains the eye-glasses, and also of the eye-glasses themselves, the field of view is made much larger, the mirror below for reflecting light is made to move upon the same bar with the stage; by which means the distance of it from the stage may be very easily and suitably varied. A condensing glass is applied under the stage in the slider-holder, in order to modify and increase the light that is reflected by the mirrors below from the light of a candle or lamp. It is furnished also with two mirrors in one frame, one concave and the other plane, of glass silvered; and by simply unscrewing the body, the instrument, when desired, may be converted into a single microscope. Fig. 12. is a representation of the instrument thus improved; and the following is the description of it, as given by Mr Adams in his Essays.

A B represents the body of the microscope, containing a double eye-glass and a body-glass: it is here shown as screwed to the arm C D, from whence it may be occasionally removed, either for the convenience of packing, or when the instrument is to be used as a single microscope.

The eye glasses and the body glasses are contained in a tube which fits into the exterior tube A B; by pulling out a little this tube when the microscope is in use, the magnifying power of each lens is increased.

The body A B of the microscope is supported by the arm C D; this arm is fixed to the main pillar C F, which is screwed firmly to the mahogany pedestal G H; there is a drawer to this pedestal, which holds the apparatus.

N I S, The plate or stage which carries the slider-holder K L: this stage is moved up or down the pillar C F, by turning the milled nut M; this nut is fixed to a pinion, that works in a toothed rack cut on one side of the pillar. By means of this pinion, the stage may be gradually raised or depressed, and the object adjusted to the focus of the different lenses.

K L is a slider-holder, which fits into a hole that is in the middle of the stage N I S; it is used to confine and guide either the motion of the sliders which contain the objects, or the glass tubes that are designed to confine small fishes for viewing the circulation of the blood. The sliders are to be passed between the two upper plates, the tubes through the bent plates.

L is a brass tube, to the upper part of which is fixed the condensing lens before spoken of; it fits into the under part of the slider-holder K L, and may be set at different distances from the object, according to its distance from the mirror or the candle.

O is the frame which holds the two reflecting mirrors, one of which is plane, the other concave. These mirrors may be moved in various directions, in order to reflect the light properly, by means of the pivots on which they move, in the semicircle Q S R, and the motion of the semicircle itself on the pin S: the concave mirror generally answers best in the day-time; the plane mirror combines better with the condensing lens,

Microscope lens, and a lamp or candle. At D there is a socket for receiving the pin of the arm Q (fig. 31.), to which the concave speculum, for reflecting light on opaque objects, is fixed. At S is a hole and slit for receiving either the nippers L (fig. 31. Pl. ccci.) or the fish-pan I; when these are used, the slider-holder must be removed. T, a hole to receive the pin of the convex lens M, fig. 31.

To use this microscope: Take it out of the box. Screw the body into the round end of the upper part of the arm C D. Place the brass sliders, which contain the magnifiers, into the dove-tailed slit which is on the under side of the aforesaid arm, as seen at E, and slide it forwards until the magnifier you mean to use is under the centre of the body: opposite to each magnifier in this slit there is a notch, and in the dove-tailed part of the arm C D there is a spring, which falls into the above-mentioned notch, and thus makes each magnifier coincide with the centre of the body. Pass the ivory slider you intend to use between the upper plates of the slider-holder K L, and then reflect as strong a light as you can on the object by means of one of the mirrors; after this, adjust the object to the focus of the magnifier and your eye, by turning the milled screw M, the motion of which raises and depresses the stage N I S. The degree of light necessary for each object, and the accuracy required in the adjustment of the lenses to their proper focal distance from the object will be easily attained by a little practice.

When *opaque* objects are to be examined, remove the slider-holder, and place the object on a flat glass, or fix it to the nippers L, the pin of these fit into the hole on the stage; screw the concave speculum R into the arm Q (fig. 31.), and then pass the pin of this arm through the socket D, fig. 12. the light is now to be reflected from the concave mirror to the silver speculum, and from this down on the object. No exact rule can be given for reflecting the light on the object; we must therefore refer the reader to the mother of all aptness, practice. The speculum must be moved lower or higher, to suit the focus of the different magnifiers and the nature of the object.

The foregoing directions apply equally to the using of this instrument as a *single microscope*; with this difference only, that the body AB is then removed, and the eye is applied to the upper surface of the arm CD, exactly over the magnifiers.

This microscope is sometimes made with the following alterations, which are supposed to make it still more convenient and useful. The arm CD that carries the body and magnifiers is made both to turn on a pin, and to slide backwards and forwards in a socket at C; so that, instead of moving the objects below on the stage, and disturbing them, the magnifiers are more conveniently brought over any part of the objects as desired. The condensing glass is made larger, and slides upon the square bar CF quite distinct from the stage, like the mirrors below; and it is thereby made useful for any other objects that may be applied on glasses fitted to the stage, as well as those put into the slider-holder K. It is thereby not confined to this stage alone, as in the preceding. When the body AB is taken away, the arm CD may be slipped away from its bar, with the magnifiers, and the forceps, wire, and joint, applied to it; and it there-

by serves the purpose of a small hand single or opaque microscope, for any object occasionally applied to this wire. The magnifiers in the slider E are mounted in a wheel case, which perhaps prevents its being in the way so much as the long slider E before described.— This contrivance is represented at X, fig. 12.

4. *Martin's New Universal Compound Microscope* — This instrument was originally constructed by the late Mr B. Martin, and intended to comprise all the uses and advantages of the single, compound, opaque, and aquatic microscopes. The following is a description of it as now made, with a few alterations, chiefly suggested (we are told) by Mr Jones of Holborn.

Fig. 13. is a representation of the instrument placed up for use. A, B, C, D, is the body of the microscope: which consists of four parts, viz. AB the eyepiece, or that containing the eye-glasses, and is screwed into C, which is a moveable or sliding tube on the top; this inner tube contains the body-glass screwed into its lower part. D is the exterior tube or case, in which the other slides up and down in an easy and steady manner. This motion of the tube C is useful to increase or decrease the magnifying power of the body-glass when thought necessary, as before mentioned. E is a pipe or snout screwed on to the body of the microscope D, and at its lower part, over the several magnifying lenses hereafter described. F G H I is the square stem of the microscope, upon which the stage R moves in an horizontal position, upwards or downward, by means of the fine rackwork of teeth and pinion. K L is a strong solid joint and pillar, by which the position of the instrument is readily altered from a vertical one to an oblique or to a perfectly horizontal one, as may be required: it is thus well adapted to the ease of the observer either sitting or standing; and as it is very often convenient to view objects by direct unreflected light, when the square stem F I is placed in an horizontal position for this purpose, the mirror T is then to be taken off in order to prevent the obstruction of the rays. M is a circular piece of brass, serving as a base to the pillar. NOP, the tripod or foot by which the whole body of the microscope is steadily supported; it folds up when packed into the case. W is a brass frame, that contains the condensing lens, and acts in conjunction with the large concave and plane mirrors below at T; the reflected rays from which, either of the common light or of that of a candle or lamp, it agreeably modifies, and makes steady in the field of view.

The particulars of the apparatus to this microscope are as follow: Q is a circular brass box, containing six magnifiers or object lenses, numbered 1, 2, 3, 4, 5, 6; the digits of which appear severally through a small round hole in the upper plate of it. To the upper side is fixed a small circle of brass, by which it is connected with, and screwed into, the round end of the arm *abcd*; which is a long piece of brass, and moves through either by teeth or pinion, or not, as may be desired, in *ef*; which is a socket on the upper part of the pillar, and admits, with a motion both easy and steady, the brass arm. R is a fixed stage, upon which the objects to be viewed are to be placed: it is firmly fastened to the square pillar, which is moved by the rackwork. In the middle is a large circular hole, for

Microscope receiving concave glasses, with fluids, &c. it has also a sliding spring-frame to fasten down slips of glass or other things: at *abc* are three small sockets or holes, intended to receive several parts of the apparatus. *S* is the refractor, or illuminating lens, for converging the sun's rays upon opaque objects laid upon the stage *R*. To this purpose it moves on a semicircle upon a long shank *g*, in a spring socket *b*, in the arm *i*; this arm moving every way by a stout pin *k* in the socket *a* of the stage. In this manner it is easily adjusted to any position of the sun, candle, &c.—*T*, the reflecting-glass frame, containing a concave and plane speculum, which is moved upon the square pillar by the hand. The use of it is to illuminate all transparent objects that are applied to the stage above.

Fig. 14. n° 1. is an auxiliary moveable stage; which by means of a pin *k* is placed in the hole *a* of the stage *R*, and can be moved in an horizontal direction over the whole field of the stage. In this stage, there are three circular holes with shouldered bottoms; a large one in the middle, and on each side a small one, for the reception of the three following necessary articles: n° 2. a watch-glass to be placed in the large hole, to hold fluids containing animalcules, &c.; a circular piece of ivory, n° 3. one side of which is black, the other white, to support opaque objects of different contrasted colours; and circular plane and concave glasses, n° 4. for extemporaneous transparent objects.—The same use is made of the other small hole as of the large one, only in a lesser degree, to receive small concave glasses, plates, &c.

* Or that adjoining to n° 8. (the n° having been omitted by the engraver).

N° 5.* is the silvered speculum, called a *Liberkhun*, which makes the single opaque microscope, by being screwed to the slider *abcd* (fig. 13.) in room of the box of lenses *Q*, and the body *AE* above it. The chief use of this is to view very small objects strongly illuminated near the compounded focus of the mirror *T* (fig. 13.) N° 6. is the forceps or pliers, for holding such kind of objects, and by which they can be applied very readily to the focus of the lens in the *liberkhun*. They have a motion all ways by means of the spring socket *a*, the joint *b*, and the shank *c*: they are placed in the socket *c* of the fixed stage *R* (fig. 13.) N° 7. is a small piece of ivory, to be placed upon the pointed end of the pliers: it is black upon one side, and white upon the other, to receive opaque objects.

N° 8. is a *liberkhun* of a larger size than that first mentioned, with a hole in its centre: this is screwed into n° 9. the hole *a* of a brass ring, fastened to a long wire *b*; which moves up and down in the spring socket *b* of the stage *R*, in which it also moves sideways; and thus, with the body *AE* above, forms an *aquatic compound microscope* for showing all sorts of objects in water and other fluids placed under it in the watch-glass n° 2. on the stage.

N° 11. is a cone, with a proper aperture *a* to exclude superfluous light, that would disturb a critical observation of a curious object; it is placed on the under side of the fixed stage *R*.

N° 12. is what is usually called a bug-box, consisting of a concave glass with a plane one screwed over it; by means of which a bug, louse, flea, &c. may be

secured and viewed alive. It is to be placed on either **Microscope** of the stages *R* (fig. 13.), or n° 1 (fig. 14.)

N° 13. is the fish-pan. In the long concave body *ab*, a fish may be so confined by the ribband *c*, that the transparent tail may be in part over the slit or hole at *a*. In this state, it is placed on the stage *R*, with the pin *d* in the hole *c* of the stage, and moves freely and horizontally for viewing the circulation of the blood, &c.

N° 14. is the slider-holder that is placed on the stage *R*: it receives the sliders and tubes when filled with transparent objects, to be viewed either by the compound or single microscope.

N° 15. represents the ivory slider, to hold the objects between the talcs as usual.

N° 16. is a useful auxiliary slider framed in brass. In this slider small concave glasses are cemented; and a slip of plane glass slides over them; by which any small living object, as mites, &c. may be confined without injury, and deliberately viewed.

N° 17. represents a set of glass tubes, three in number, one within another; they are useful for small tadpoles, water-newts, eels, &c. when the circulation of the blood is to be viewed. There is a small hole at one end of each tube, that serves to admit the air; for when they are filled with water, the other end is stopped with a cork.

N° 18. is a small ivory box, containing spare talcs and wires, to supply the sliders with occasionally.

N° 19. a brass cell or button, containing a very small lens, properly set between two small plates of brass, that it may be brought very near to the object when viewed therewith as a single microscope. This magnifier is screwed into the same hole as the wheel of six magnifiers *Q* are (fig. 13).

N° 20. is a lens, adapted to view and examine objects, by magnifying them sufficiently, so as to be able to apply them to the microscope for inspection: on this account it is called the *explorator*.

The preceding are the chief articles of the apparatus; which, on account of their being somewhat different from what is applied to other microscopes, we have been thus particular in describing. In using the microscope, and while viewing objects by either the single or compound instrument, the focal distances of the magnifiers are made perfectly exact by turning of the pinion at the nut *w*, in one way or the other, very gently in the teeth of the rack-work at *X* (fig. 13).

It is necessary that the centres of the object lenses or magnifiers, the stage, and the mirrors at bottom, should all be in a right line in the axis of the microscope, when opaque objects are to be viewed, that are placed upon the ivory piece n° 7, or the forceps n° 6. and all other such sort of objects which are placed in the centre of the stage *R*, or slider-holder n° 14: But when aquatic or living objects, which require a great space to move in, are to be viewed, then the horizontal motion at *ef* (fig. 13.) is made use of, and the view may be extended laterally over the whole of the diameter of the object or field of view; and by putting the arm *abcd* forward or backward in its socket *ef*, the view is extended in the contrary direction equally well; and in this manner the whole

of

MICROSCOPE.

Plate CCXCIX.

Fig. 13.

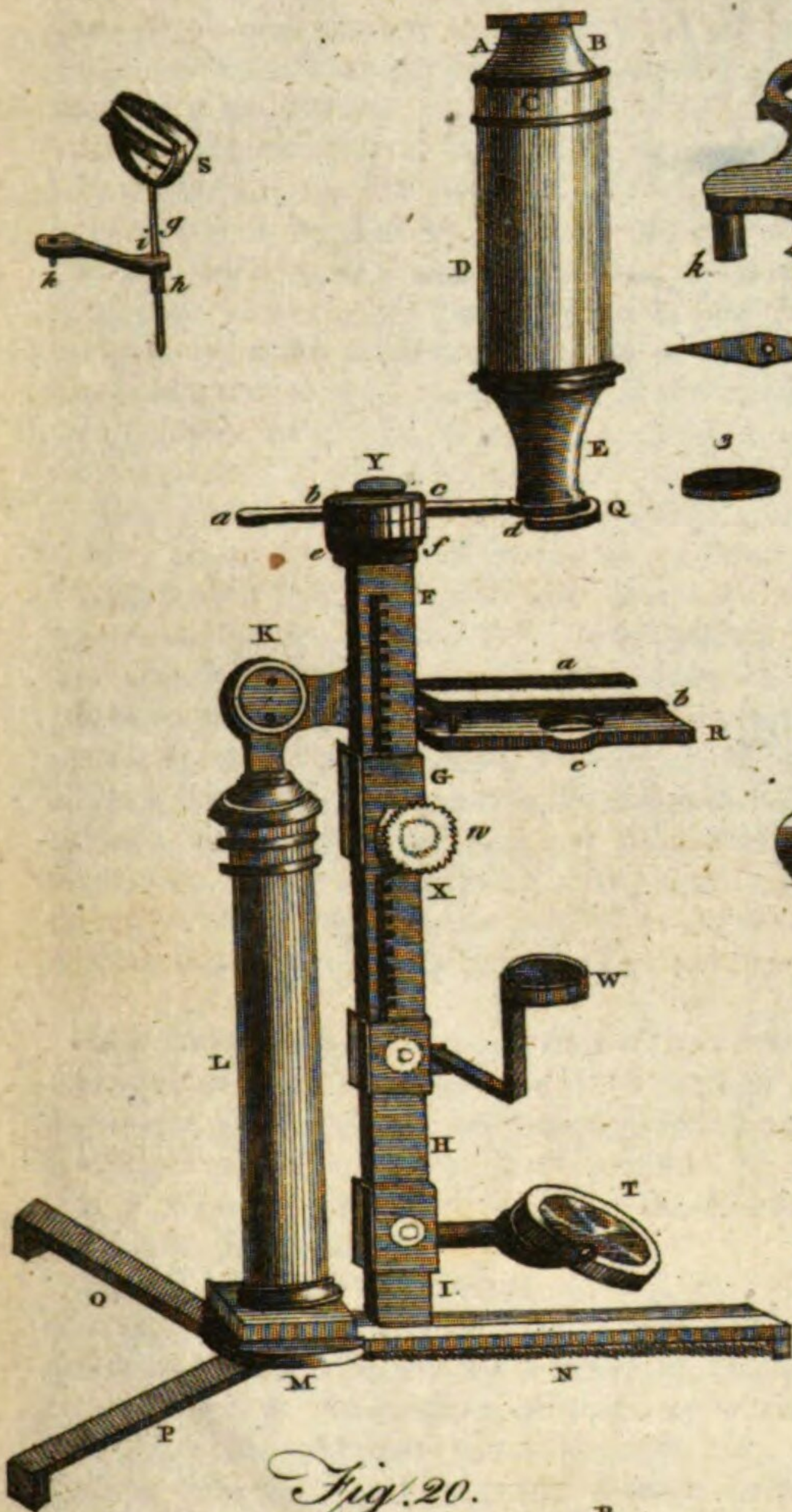


Fig. 14.

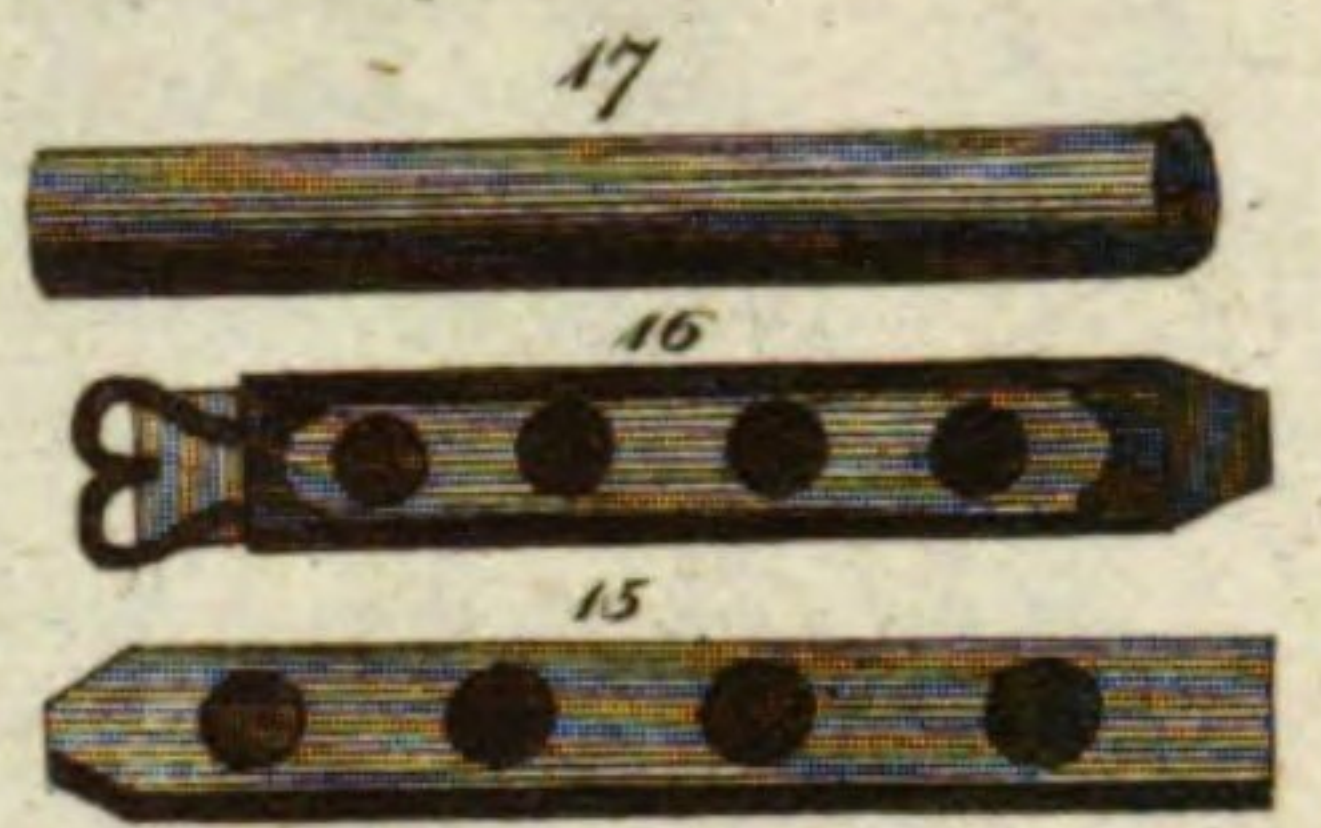
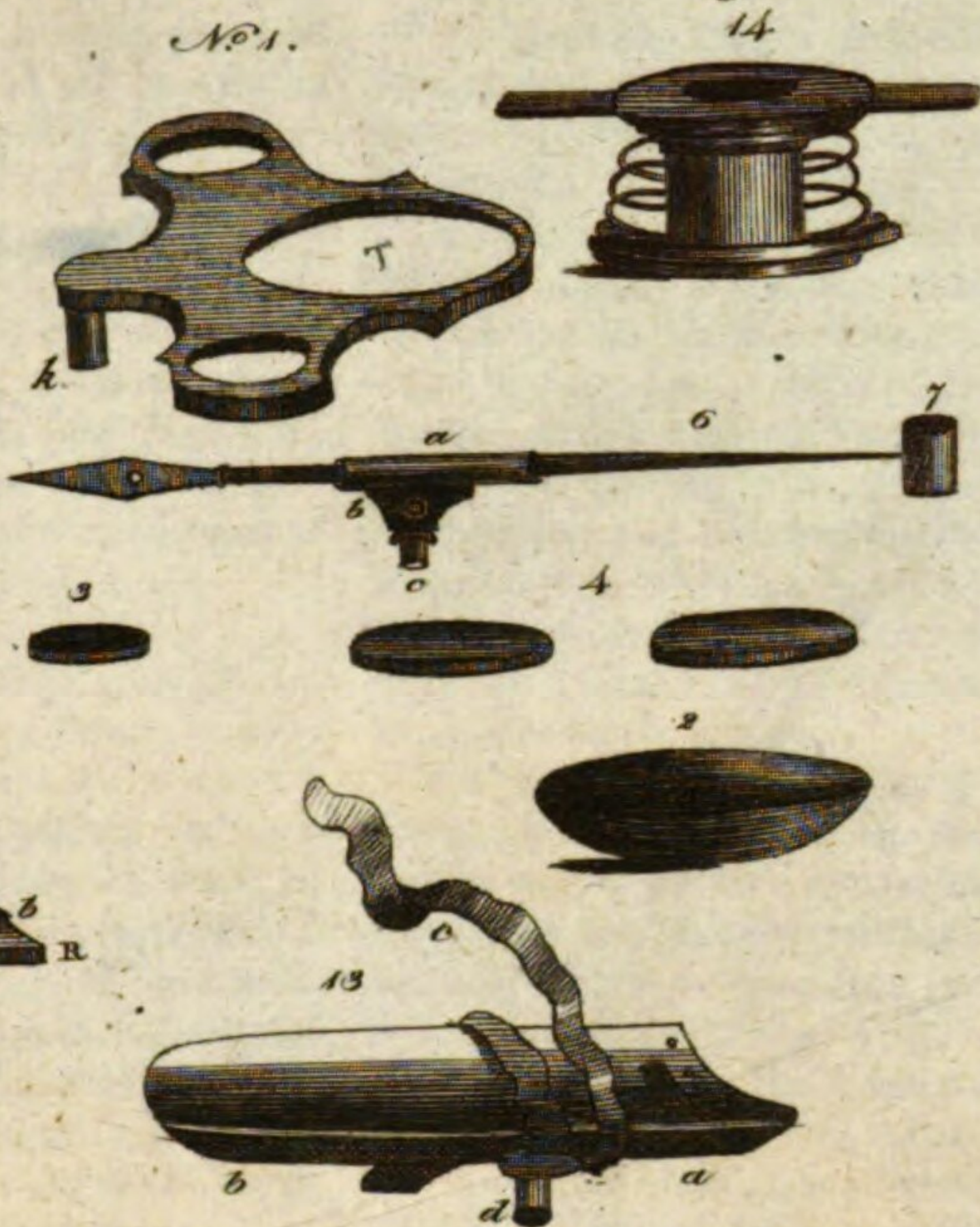


Fig. 16.

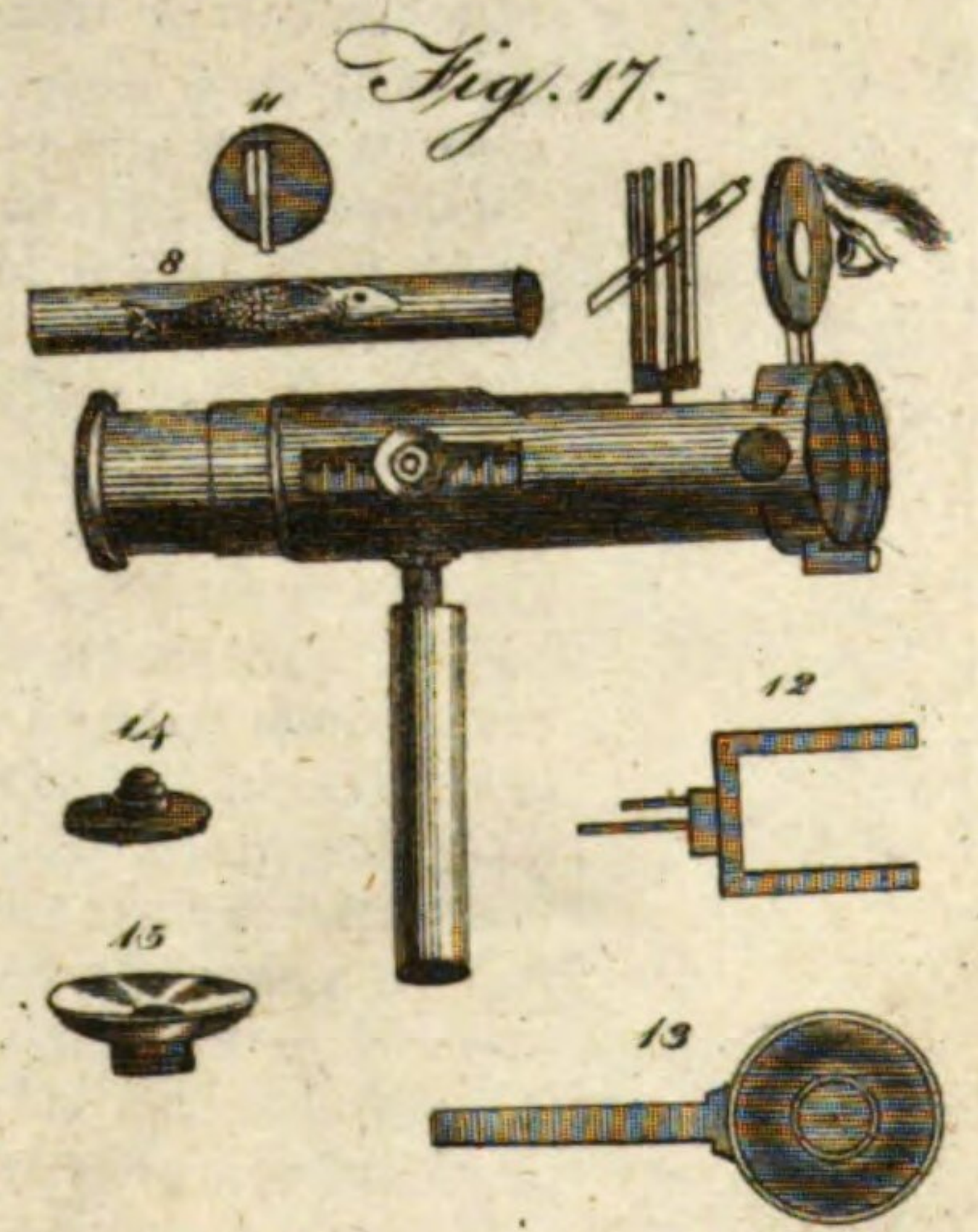
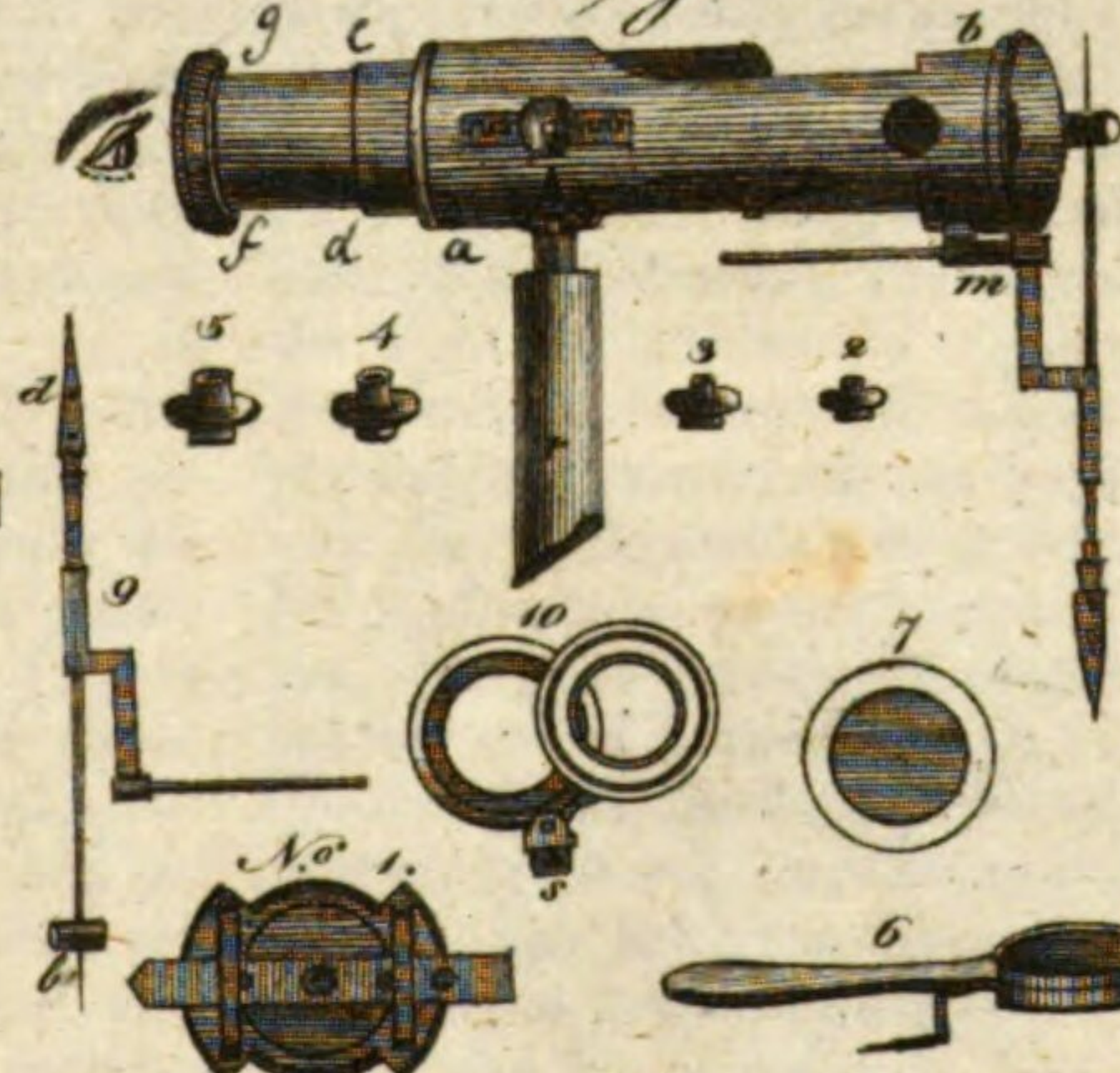


Fig. 20.

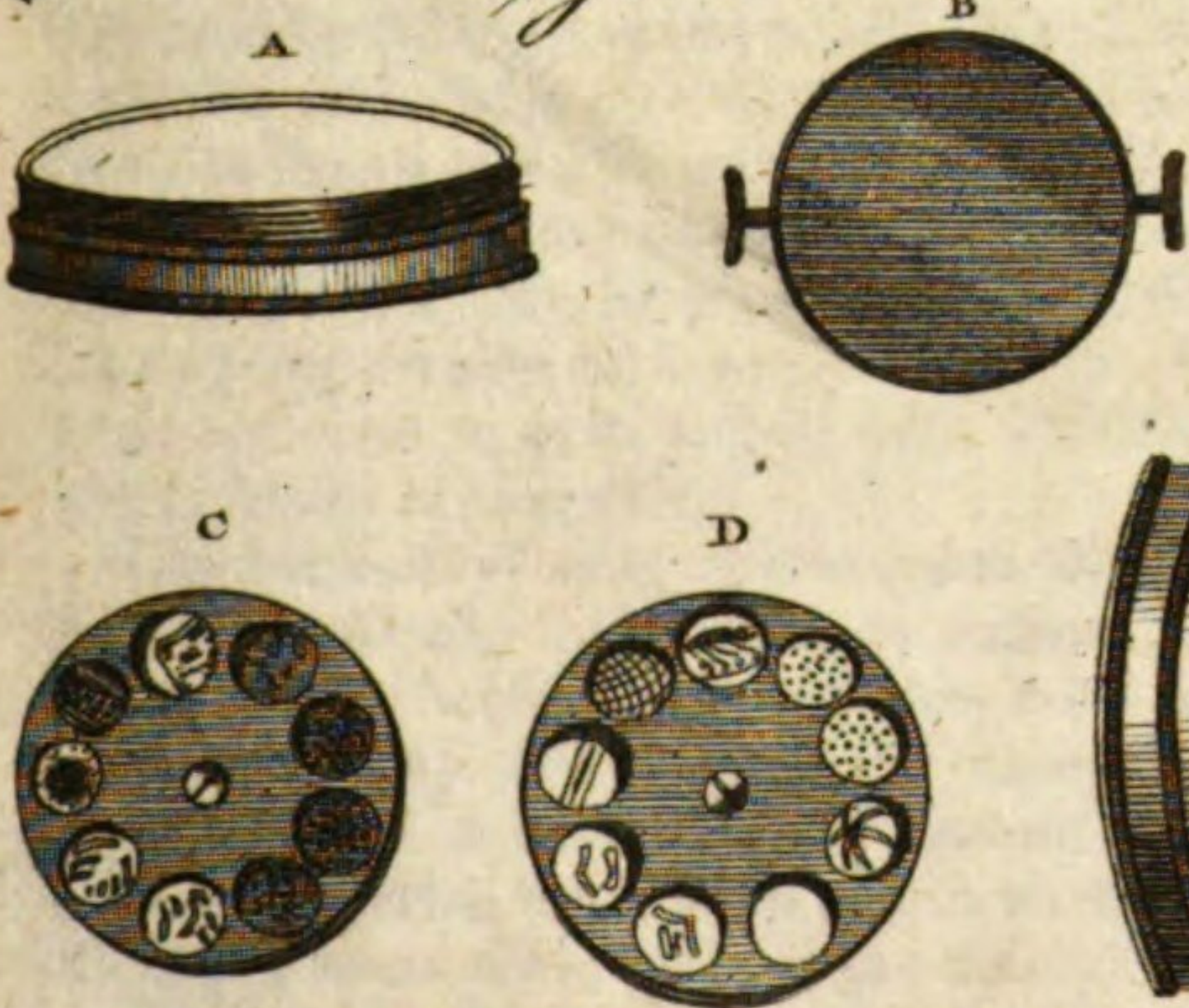


Fig. 19.



Fig. 18.

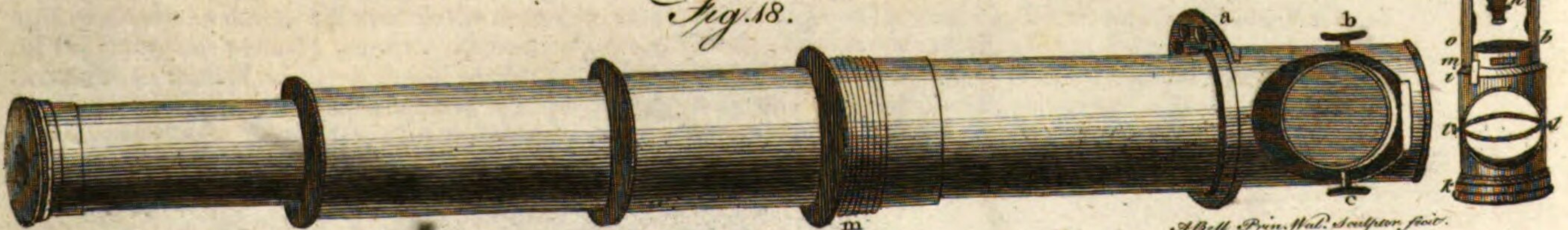
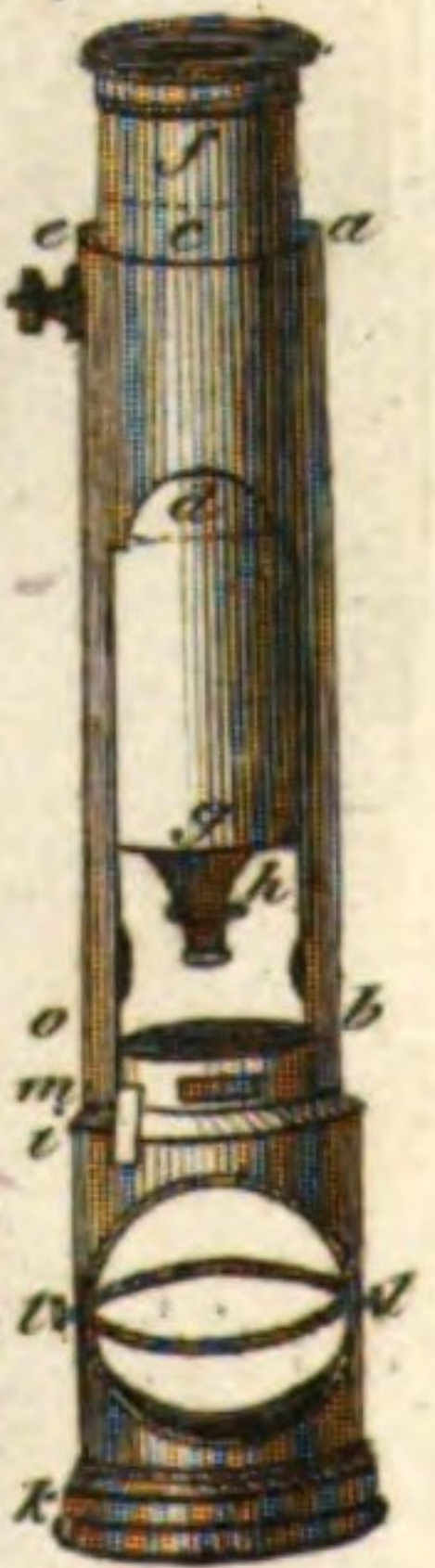


Fig. 15.



A. Bell Pin. Wal. Sculptor. fecit.

Microscope of the objects may be viewed without the least disturbance.

As the brass arm *abcd* may be brought to the height of three or four inches above the stage R; so, by means of the rack-work motion of the stage, a lens of a greater focal distance than the greatest in the wheel Q may be occasionally applied in place of the wheel, and thereby the larger kind of objects be viewed; the instrument becoming, in this case, what is called a *megala-scope*.

In viewing moving living objects, or even fixed ones, when nice motions are requisite, a rack-work and pinion is often applied to the arm *abcd*: the arm is cut out with teeth; and the pinion, as shown at Y, is applied to work it. This acts but in one direction; and, in order to produce an equally necessary motion perpendicular to this, rack-work and pinion is applied tangent-wise to the stage, which is then jointed.

What has been related above respects the construction of those denominated *parlour* microscopes, in contradistinction to those which are portable: their dimensions, however, have been considerably reduced by opticians, in order to render them fit for the pocket; and as they are for the most part constructed on nearly the same principles as those which have been already described, what has been said will sufficiently instruct our readers in using any pocket microscope whatever. Only it may be observed, that in those reduced instruments, both the field of view and the magnifying power are proportionably diminished.

We shall conclude the account of this sort of microscope with descriptions of a very portable pocket apparatus of microscopic instruments, and of a new microscopic pocket-telescope, both invented by the late Mr B. Martin, and since made by most instrument-makers in London.

The former is represented at fig. 15. It consists of two parts, viz. the body *ab*, and the pedestal *ik*, which is joined by a screw at the part between *b* and *i*. It consists of three cylindric tubes, viz. (1.) the exterior tube, or case *ab*; (2.) a middle tube *cb*; and (3.) the interior tube *fg*.—The middle tube *cd* is the adjuster; and is connected with the outer tube by the rack-work of teeth and pinion, as shown at *e*: by which means it is moved up and down at pleasure through the smallest space, and carries with it the internal tube *fg*. The interior tube *fg* receives on its lower part at *b* the several capsules or boxes 2, 3, 4, 5, (fig. 16.) which contain the object lenses or magnifiers.

The method of using this compound microscope in the perpendicular position, is as follows. The stage n° 1. is put within the exterior tube at *b*. Under the springs are applied the four ivory sliders, which contain a variety of transparent objects; then move the interior tube *fg* up and down with the hand, till you discern the object in the slider, and there let it rest. After this, turn the pinion at *e* very tenderly one way or the other, till you obtain a perfect view of the transparent objects properly illuminated, from a mirror contained in the pedestal or stand *ik*, suspended upon, and moveable about, the points of two screws (!!). N° 6. (fig. 16.) represents a move-

able stage, which is placed in the spring socket *m*. It contains a concave glass, for the reception of animalcules in fluids; and has the advantage of bringing any part into view by moving the handle at *n*. If living and moving objects are required to be shown, they must be confined in the concave, by putting a glass cover, n° 7. upon the stage; and then a small spider, a louse, flea, bug, &c. may be seen, and the motion or circulation of the blood, &c. observed with surprising distinctness.

To view the circulation of the blood in the most eminent degree, it must be done by placing small frogs, tadpoles, water-newts, fishes, &c. in a tube as represented n° 8. (fig. 17.); which tube is placed in the holes *o* in the opposite sides of the case *ab*, fig. 15. in the lower part.—N° 9. (fig. 16.) is a pair of pincers or pliers *d*, for holding any object; the other end of the steel wire is pointed to receive a piece of ivory *b*, with one end black, and the other white, on which you stick objects of different hue: this also, when used, is placed in the spring socket *m*.

To use this instrument as a compound opaque, you screw off the body part *ab*, and screw to it the handle *r* (fig. 16.); by this means you may hold the microscope in a horizontal position, as shown in the figure. The silver dish or speculum (which is contained in the bottom or base *k*, fig. 15), is then screwed on at *b*. N° 9. is placed in the spring-socket *m*, and adjusted backward and forward in *m*, till the reflected light from the speculum falls in a proper manner on the opaque object. Either of the 4 magnifiers, 2, 3, 4, 5, may be used, and brought to a proper focus, as before described, by the tooth and pinion *e* (fig. 15.) If you take off the opaque apparatus, and apply the stage n° 1. (fig. 16.) with an ivory slider, and at the end *b* screw in either of the two lenses, n° 10. (which are distinguished by the name of illuminators), the microscope being held up to the light (and properly adjusted), the whole field of view will be strongly illuminated, and present a most pleasing appearance of any transparent object. These two convex lenses are of different focuses, and are to be used singly or together; n° 2. being the greatest magnifier, will require the object to be strongly illuminated, and of course both the lenses must be used together. By candle-light, this method of viewing transparent objects will prove very entertaining; by screwing the handle *r* into the part *s* of n° 10. it becomes a delightful hand megala-scope for viewing flowers, fossils, shells, &c.; and each lens, as before mentioned, having a different focus, produces two magnifying powers used singly, and when combined a third.

The manner of using this instrument as a single microscope (like Wilson's) is represented in fig. 17. where the button or magnifier at each is to be screwed off, and the circular piece n° 11. is screwed in its place. This piece has a spring socket made to receive the slider holder n° 12. N° 13. is a circular piece of brass, with a long shank and spring, and is introduced through the outside tube *ab* at *t*. N° 2, 3, 4, 5, are screwed occasionally in the centre of this piece, and used as single lenses with ivory sliders, &c. N° 14. contains a lens of a great magnifying power, for viewing very minute objects: to render this instrument the most complete single opaque microscope, you have only to screw into n° 13. the silver speculum

Microscope n° 15, which has a small lens set in its centre. The slider-holder n° 12 is taken out of n° 11, and the pincers or nippers *db*, being detached from the other part of n° 9, are passed through the long spring socket n° 11, and ready to receive any opaque body in the pincers or on the black and white piece of ivory. To the large screw of n° 13, are applied the two lenses n° 10, which make it the completest megalascope that can be desired.

The handle *r* contains the four ivory sliders with objects.

The shagreen case which contains this universal microscope and its apparatus, is six inches long, three inches wide, two inches deep, and weighs together 16 ounces. "Thus (says Mr Martin) so small, so light, so portable, and yet so universally complete, is this pocket microscopic apparatus, that you find nothing material in the large three-pillared microscope, the opaque microscope, Wilson's single microscope, and the aquatic microscope, all together, which you have not in this; beside some very considerable advantages in regard to the field of view, &c. which they have not (A)."

This inventive artist having contrived a construction of the compound microscope so small as to admit of being packed in a common walking cane, thought next of introducing the same instrument into the inside of what he called his *Pocket Three-brass drawer Achromatic Telescope*. The same eye-glasses that serve the purpose of a telescope, answer as the compound magnifier, for viewing transparent and opaque objects in a microscope.

Fig. 18, 19, 20. represent the telescope separated by unscrewing it at *m*, in order that the whole of the necessary parts in use may be exhibited. Fig. 19. represents the exterior tube, which is of mahogany, and its rims of brass. It is detached from the rest of the telescope, as not making any part of the microscope. The brass cover *kl*, that shuts up the object-glass of the telescope, is also the box which contains the two-wheel object-frames, and a small plain reflecting mirror.

In fig. 20. *A* is the cover taken off, by unscrewing the top part: The mirror *B* is taken out; and also, by unscrewing the bottom part, the two circular wheels, with the objects shown in *C* and *D*.

Fig. 18. is a representation of the three internal brass sliding tubes of the telescope, which form the microscopic part. The tubes are to be drawn out as shown in this figure; then, at the lower end of the large tube in the inside, is to be pulled out a short tube *bc*, that serves as a kind of stage to hold the wheels with objects, and support the reflecting mirror. This tube is to be partly drawn out, and turned so that the circular hole that is pierced in it may coincide with a similar hole that is cut in the exterior tube.

This tube is represented as drawn out in the figure; Microscope and the mirror *B* placed therein, and the wheel with transparent objects. *C* (fig. 20.) represents the wheel with transparent objects, and *D* the wheel with opaque objects. They are both made of ivory; and turn round upon a centre *fs* pin slit upon the top, which fits upon the edge of the tube; which tube is then to be pushed up into the telescope tube, so that its lower end may rest upon the upper edge of the wheel according to its view at *a* fig. 18.

In viewing the objects, the second brass tube of the telescope must be pushed down, till its milled edge at top falls upon that of the exterior tube; taking care that the circular hole is duly placed to the exterior one. These circular holes are not seen in fig. 18. being supposed in the opposite side, where the wheel is fixed. The adjustment for the focus is now only necessary; which is obtained by pushing downwards or upwards the proper tube, till the object appear quite distinct. In viewing transparent objects, the instrument may be used in two positions; one vertical, when the light is to be reflected upon the object by the mirror; the other, by looking up directly against the light of a candle, common light, &c.; in which case the mirror must be taken away. In viewing opaque objects, the mirror is not used; but as much common light as possible must be admitted through the circular holes in the sides of the tubes.

There is a spare hole in the transparent wheel, and also one in the opaque, to receive any occasional object that is to be viewed. Any sort of object whatsoever may be viewed, by only pushing up the microscope tube into its exterior, and bringing the first eye-tube to its focal distance from the object.

The brass tubes are so contrived, that they stop when drawn out to the full length: so that by applying one hand to the outside tube, and the other to the end of the smallest tube, the telescope at one pull may be drawn out; then any of the tubes (that next to the eye is best) may be pushed in gradually, till the most distinct view of the object be obtained.

The tubes all slide through short brass spring tubes, any of which may be unscrewed from the ends of the sliding tubes by means of the milled edges which project above the tubes, taken from each other, and the springs set clear if required.

III. Of SOLAR Microscopes.

This instrument, in its principle, is composed of a tube, a looking-glass or mirror, a convex lens, and Wilson's single microscope before described. The sun's rays being reflected through the tube by means of the mirror upon the object, the image or picture of the object is thrown distinctly and beautifully upon a screen of white paper or a white linen sheet, placed at

Plate
CCC.

(A) Notwithstanding the properties that have been ascribed to the above instrument, and the praises bestowed upon it by some, which induced us to admit so minute a description; we must apprise our readers, that it has been omitted in Mr Adams's enumeration: and upon inquiry we learn, that it has fallen into neglect among the most judicious opticians, being found too imperfect to serve the purposes of science, and too complicated for the use of persons who seek only entertainment.

Microscope at a proper distance to receive the same; and may be magnified to a size not to be conceived by those who have not seen it: for the farther the screen is removed, the larger will the object appear; insomuch, that a louse may thus be magnified to the length of five or six feet, or even a great deal more; though it is more distinct when not enlarged to above half that size.

The different forms in which the Solar Microscope is constructed, are as follow.

I. The old construction is represented in fig. 21. A is a square wooden frame, through which pass two long screws assisted by a couple of nuts 1, 1. By these it is fastened firmly to a window shutter, wherein a hole is made for its reception; the two nuts being let into the shutter, and made fast thereto. A circular hole is made in the middle of this frame to receive the piece of wood B, of a circular figure; whose edge, that projects a little beyond the frame, composes a shallow groove 2, wherein runs a catgut 3; which, by twisting round, and then crossing over a brass pulley 4, (the handle whereof 5, passes through the frame), affords an easy motion for turning round the circular piece of wood B, with all the parts affixed to it. C is a brass tube, which, screwing into the middle of the circular piece of wood, becomes a case for the uncovered brass tube D to be drawn backwards or forwards in. E is a smaller tube, of about one inch in length, cemented to the end of the larger tube D. F is another brass tube, made to slide over the above described tube E; and to the end of this the microscope must be screwed, when we come to use it. 5. a convex lens, whose focus is about 12 inches, designed to collect the sun's rays, and throw them more strongly upon the object. G is a looking-glass of an oblong figure, set in a wooden frame, fastened by hinges in the circular piece of wood B, and turning about therewith by means of the abovementioned cat-gut. H is a jointed wire, partly brass and partly iron; the brass part whereof 6, which is flat, being fastened to the mirror, and the iron part 7, which is round, passing through the wooden frame, enable the observer, by putting it backwards or forwards, to elevate or depress the mirror according to the sun's altitude. There is a brass ring at the end of the jointed wire 8, whereby to manage it with the greater ease. The extremities of the cat-gut are fastened to a brass pin, by turning of which it may be braced up, if at any time it becomes too slack.

When this microscope is employed, the room must be rendered as dark as possible; for on the darkness of the room, and the brightness of the sunshine, depend the sharpness and perfection of your image. Then putting the looking-glass G through the hole in your window-shutter, fasten the square frame A to the shutter by its two screws and nuts 1, 1. This done, adjust your looking-glass to the elevation and situation of the sun, by means of the jointed wire H, together with the cat-gut and pulley, 3, 4. For the first of these raising or lowering the glass, and the other inclining it to either side, there results a twofold motion, which may easily be so managed as to bring the glass to a right position, that is, to make it reflect the sun's rays directly through the lens 5, upon the paper screen, and form thereon a spot of light exactly round.

But though the obtaining a perfect circular spot of Microscope light upon the screen before you apply the microscope, is a certain proof that your mirror is adjusted right, that proof must not always be expected: for the sun is so low in winter, that if it shine in a direct line against the window, it cannot then afford a spot of light exactly round; but if it be on either side, a round spot may be obtained, even in December. As soon as this appears, screw the tube C into the brass collar provided for it in the middle of your wood-work, taking care not to alter your looking-glass: then screwing the magnifier you choose to employ to the end of your microscope in the usual manner, take away the lens at the other end thereof, and place a slider, containing the objects to be examined, between the thin brass plates, as in the other ways of using the microscope.

Things being thus prepared, screw the body of the microscope over the small end E of the brass tube F; which slip over the small end E of the tube D, and pull out the said tube D less or more as your object is capable of enduring the sun's heat. Dead objects may be brought within about an inch of the focus of the convex lens 5; but the distance must be shortened for living creatures, or they will soon be killed.

If the light fall not exactly right, you may easily, by a gentle motion of the jointed wire and pulley, direct it through the axis of the microscopic lens. The short tube F, to which the microscope is screwed, renders it easy, by sliding it backwards or forwards on the other tube E, to bring the objects to their focal distance; which will be known by the sharpness and clearness of their appearance: they may also be turned round by the same means without being in the least disordered.

The magnifiers most useful in the solar microscope are in general, the fourth, fifth, or sixth. The screen on which the representations of the objects are thrown, is usually composed of a sheet of the largest elephant paper, strained on a frame which slides up or down, or turns about at pleasure on a round wooden pillar, after the manner of some fire-screens. Larger screens may also be made of several sheets of the same paper pasted together on cloth, and let down from the ceiling with a roller like a large map.

"This microscope (says Mr Baker) is the most entertaining of any; and perhaps the most capable of making discoveries in objects that are not too opaque: as it shows them much larger than can be done any other way. There are also several conveniences attending it, which no other microscope can have: for the weakest eyes may use it without the least straining or fatigue: numbers of people together may view any object at the same time; and by pointing to the particular parts thereof, and discoursing on what lies before them, may be able better to understand one another, and more likely to find out the truth, than in other microscopes, where they must peep one after another, and perhaps see the object neither in the same light nor in the same position. Those also, who have no skill in drawing, may, by this contrivance, easily sketch out the exact figure of any object they have a mind to preserve a picture of; since they need only fasten a paper on the screen, and trace
it

Microscope it out thereon either with a pen or pencil, as it appears before them. It is worth the while of those who are desirous of taking many draughts in this way, to get a frame, wherein a sheet of paper may be put in or taken out at pleasure; for if the paper be single, the image of an object will be seen almost as plainly on the back as on the fore-side; and, by standing behind the screen, the shade of the hand will not obstruct the light in drawing, as it must in some degree when one stands before it." This construction, however, has now become rather obsolete, and is superseded by the following.

II. *The improved Solar Microscope, as used with the improved single Microscope, with teeth and pinion.* Fig. 22. represents the whole form of the *single microscope*; the parts of which are as follows: ABCD the external tube; GHIK the internal moveable one; QM part of another tube within the last, at one end of which is fixed a plate of brass hollowed in the middle, for receiving the glass tubes: there is also a moveable flat plate, between which, and the fixed end of the second tube, the ivory sliders are to be placed. L, a part of the microscope, containing a wire spiral spring, keeping the tube QM with its plates firm against the fixed part IK of the second tube.

EF is the small rack-work of teeth and pinion, by which the tube IG is moved gradually to or from the end AB, for adjusting the objects exactly to the focus of different lengths. NO is a brass slider, with six magnifiers; any one of which may easily be placed before the object. It is known when either of the glasses is in the centre of the eye-hole, by a small spring falling into a notch in the side of the slider, made against each of the glasses. Those parts of the apparatus, fig. 14. (Pl. ccxcix.) marked n° 15, 16, 17, 18, 19, 20, 21. and 22. are made use of here to this microscope. GH is a brass cell, which holds an illuminating glass for converging the sun's beams or the light of a candle strongly upon the objects. The aperture of the glass is made greater or less, by two circular pieces of brass, with holes of different sizes, that are screwed separately over the said lens. But at times, objects appear best when the microscope is held up to the common light only, without this glass. It is also taken away when the microscope is applied to the apparatus now to be described.

Fig. 23. represents the apparatus, with the single microscope screwed to it, which constitutes the *Solar Microscope*. AB is the inner moveable tube, to which the single microscope is screwed. CD, is the external tube, containing a condensing convex glass at the end D, and is screwed into the plate EF, which is cut with teeth at its circumference, and moved by the pinion I, that is fixed with the plate GH. This plate is screwed fast against the window-shutter, or board fitted to a convenient window of a darkened room, when the instrument is used. KL is a long frame, fixed to the circular plate EF; containing a looking-glass or mirror for reflecting the solar rays through the lens in the body of the tube D. O is a brass milled head, fastened to a worm or endless screw; which on the outside turns a small wheel, by which the reflecting mirror M is moved upwards or downwards.

In using this microscope, the square frame GH is first to be screwed to the window-shutter, and the N° 218.

room well darkened: which is best done by cutting *Microscope* a round hole of the size of the moveable plate EF, that carries the reflector, in the window-shutter or board; and, by means of two brass nuts *a a*, let into the shutter to receive the screws PP, when placed through the holes in the square frame GH, at the two holes QQ; which will firmly fasten the microscope to the shutter, and is easily taken away by only unscrewing the screws PP.

The white paper screen, or white cloth, to receive the images, is to be placed several feet distant from the window: which will make the representations the larger in proportion to the distance. The usual distances are from 6 to 16 feet.

The frame KL, with its mirror M, is to be moved by turning the pinion I, one way or the other, till the beams of the sun's light come through the hole into the room: then, by turning of the worm at O, the mirror must be raised or depressed till the rays become perfectly horizontal, and go straight across the room to the screen. The tube CD, with its lens at D, is now to be screwed into the hole of the circular plate EF: by this glass the rays will be converged to a focus; and from thence proceed diverging to the screen, and there make a large circle of light. The single microscope, fig. 22. is to be screwed on to the end AB (fig. 23.) of the inner tube; and the slider NO, with either of the lenses marked 1, 2, 3, 4, 5, or 6, in the centre of the hole at the end AB. This will occasion a circle of light upon the screen much larger than before. The slider or glass-tube, with the objects to be viewed, is to be placed between the plates at IK against the small magnifier, and moved at pleasure. By shifting the tube AB in or out, you may place the object in such a part of the condensed rays as shall be sufficient to illuminate it, and not scorch or burn it; which will generally require the glass to be about one inch distant from the focus. It now remains only to adjust the object, or to bring it so near to the magnifier that its image formed upon the screen shall be the most distinct or perfect: and it is effected by gently turning the pinion F, fig. 22, a small matter one way or the other. If the object be rather large in size, the least magnifiers are generally used, and *vice versa*.

N° 1. is the greatest magnifier, and n° 6. the least, in the brass slider NO. But, if desired, single lenses of greater magnifying powers are made: and they are applied, by being screwed to the end AB, fig. 22. and the brass slider N O is then taken away.

The same object may be variously magnified, by the lenses severally applied to it; and the degree of magnifying power is easily known by this rule: *As the distance of the object is to that of its image from the magnifier; so is the length or breadth of the object to that of the image.*

Instead of the brass sliders with the lenses NO, there is sometimes screwed a lens of a large size, and longer focal distance: the instrument is then converted into a *megascopes*; and is adapted for viewing the larger kind of objects contained in large sliders, such as is represented at R. And, in the same manner, small objects of entertainment, painted upon glass like the sliders of a magic lanthorn, are much magnified, and represented upon the same screen.

The solar microscopes just described are capable, only

Fig. 25.

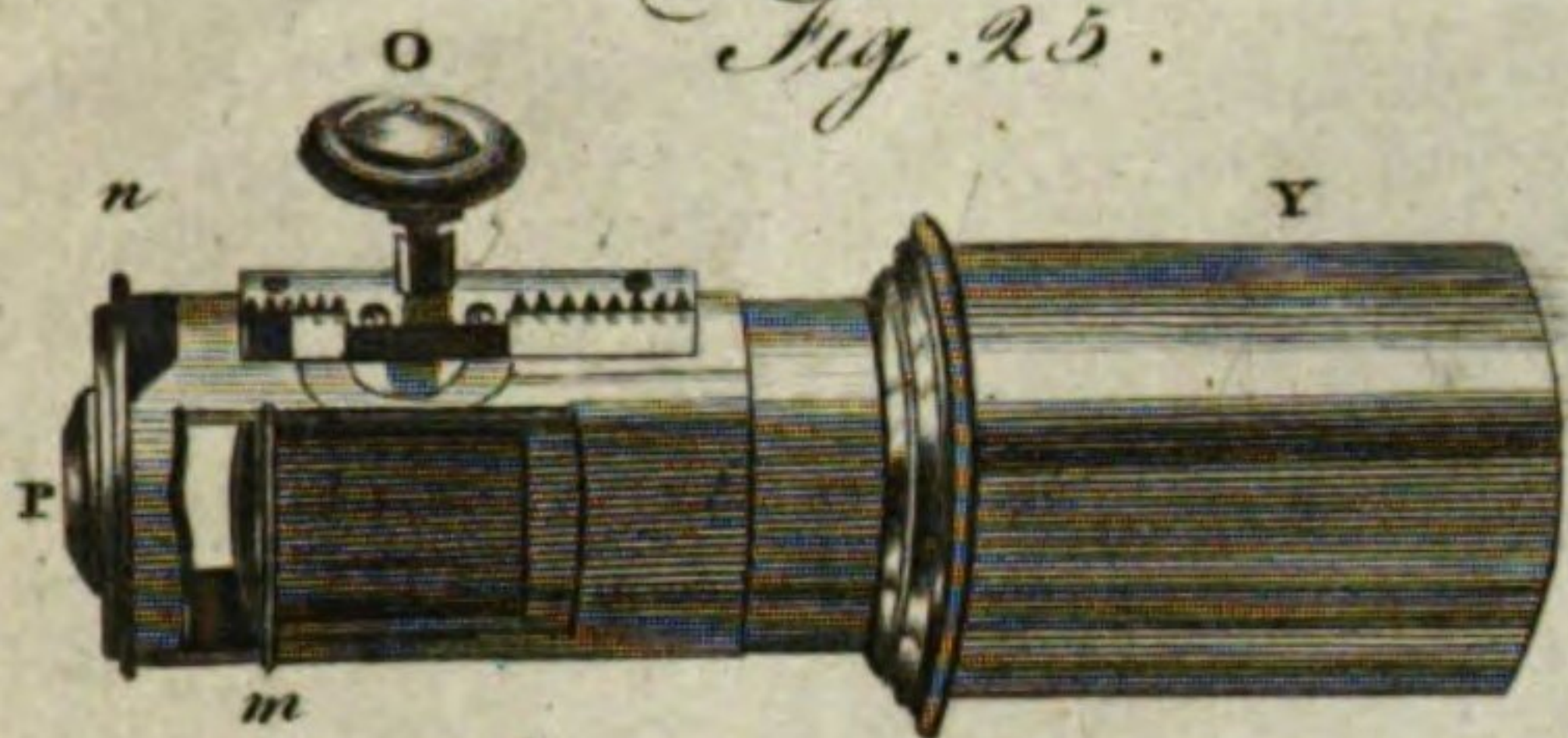


Fig. 21.

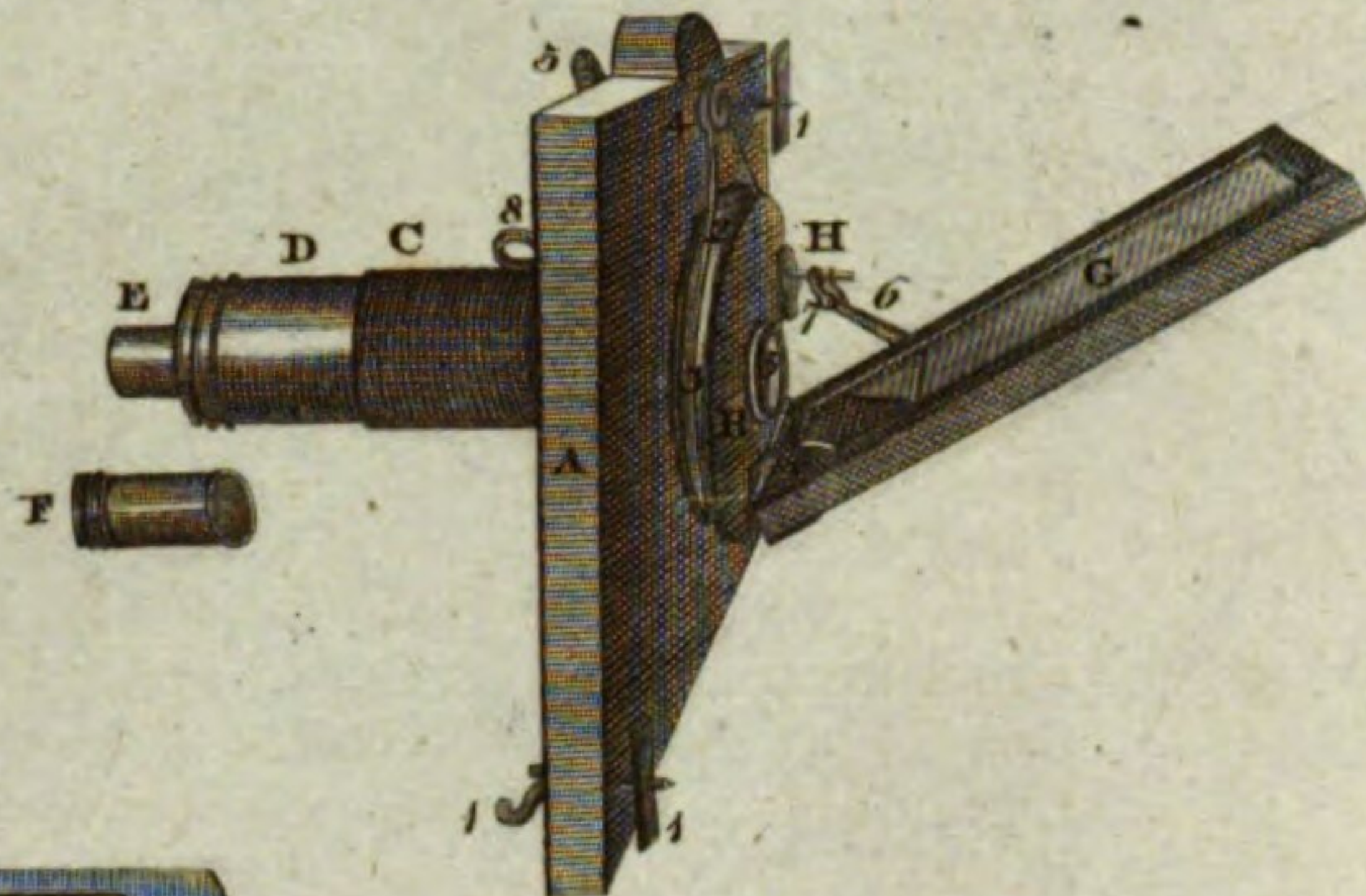


Fig. 23.

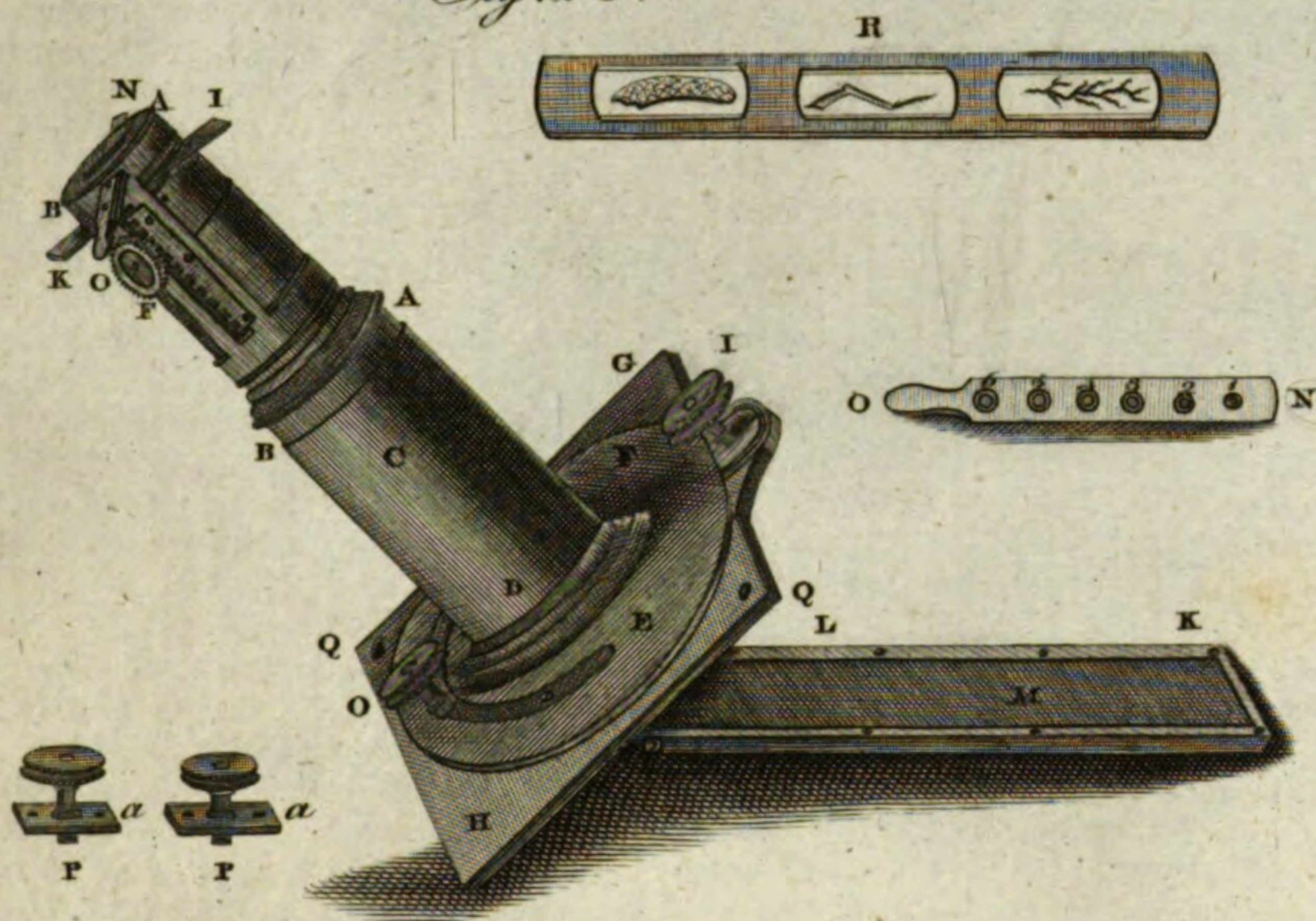


Fig. 22.

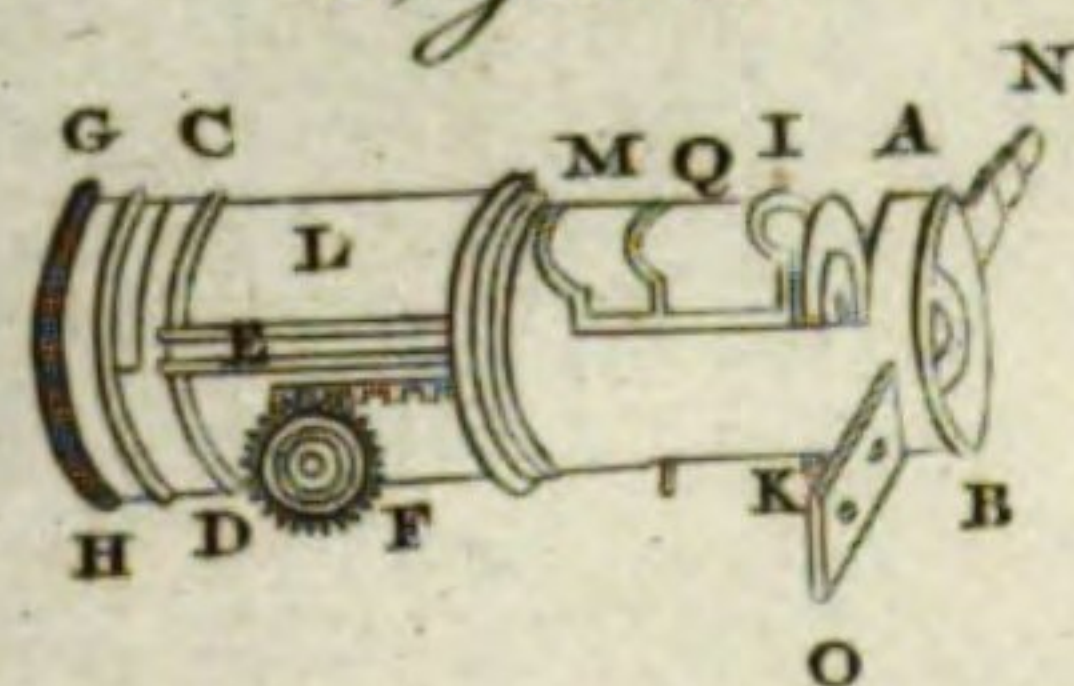
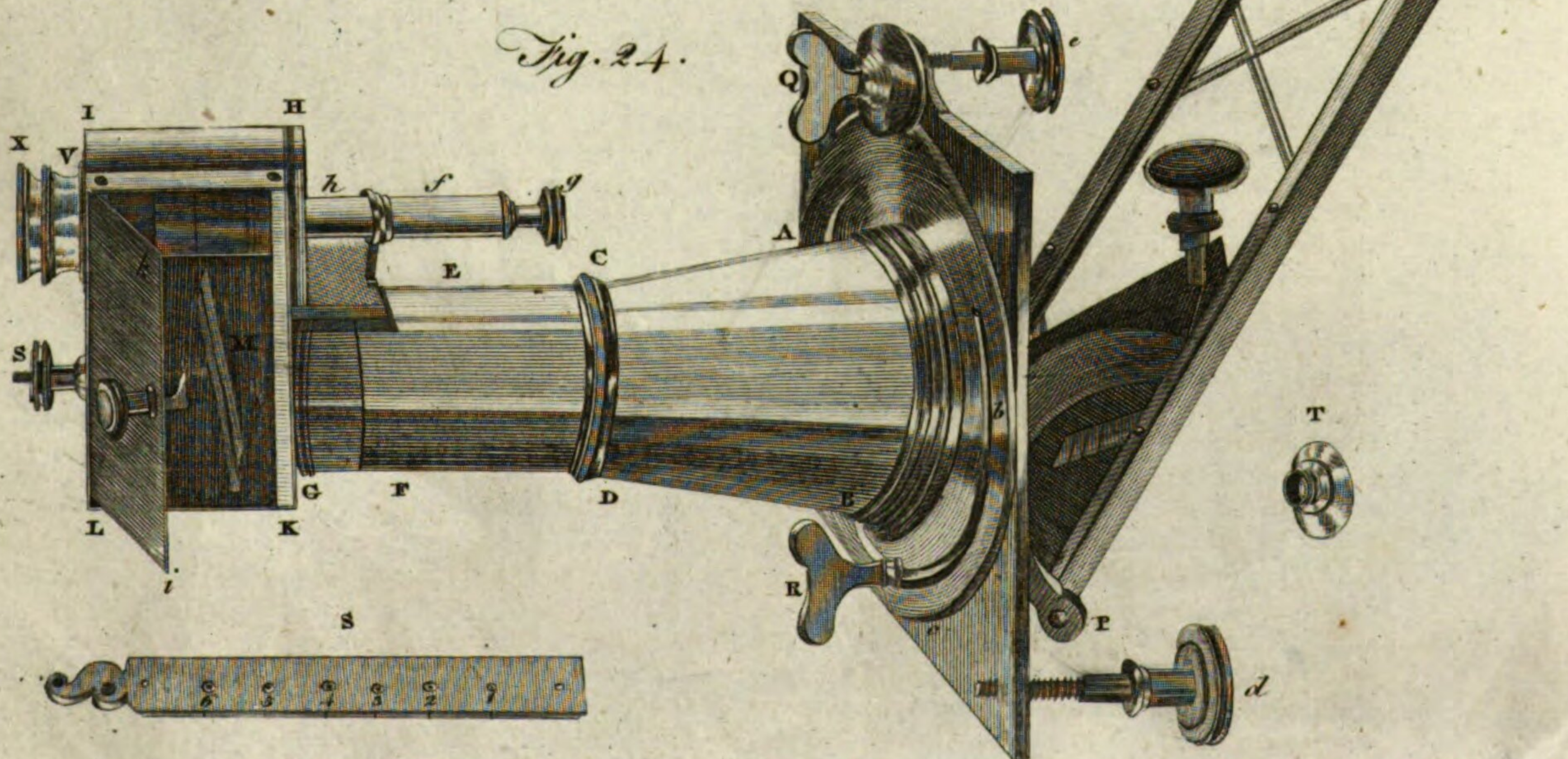


Fig. 24.



Microscopely of magnifying transparent objects; for which purpose the last instrument is extremely well adapted. But as opaque objects form the most considerable part of the curious collections in the works of art as well as nature, a solar microscope for this purpose was a long time wanted.—For several years previous to 1774, the late Mr Martin made several essays towards the construction of such an instrument; and at last completed one about the time just mentioned, which he named,

III. *The Opaque Solar Microscope.* With this instrument (to use his own words) all *opaque* objects, whether of the animal, vegetable, or mineral kingdom, may be exhibited in great perfection, in all their native beauty; the lights and shades, the prominences and cavities, and all the varieties of different hues, tints, and colours; heightened by reflection of the solar rays condensed upon them.—*Transparent objects* are also shown with greater perfection than by the common solar microscope.

Fig. 24. represents the solar opaque microscope, mounted for exhibiting opaque objects.

Fig. 25. is the single tooth-and-pinion microscope, as before, which is used for showing transparent objects; the cylindrical tube Y thereof being made to fit into the tube FE of the solar microscope.

ABCDEF, (fig. 24.) represents the body of the solar microscope; one part thereof, ABCD, is conical; the other, CDEF, is cylindrical. The cylindrical part receives the tube G of the opaque box, or the tube Y of the single microscope. At the large end AB of the conical part, there is a lens to receive the rays from the mirror, and refract them towards the box HIKL. NOP is a brass frame; which is fixed to the moveable circular plate *abc*: in this frame there is a plane mirror, to reflect the solar rays on the aforementioned lens. This mirror may be moved into the most convenient position for reflecting the light, by means of the nuts Q and R. By the nut Q it may be moved from east to west; and it may be elevated or depressed by the nut R. *de*, Two screws to fasten the microscope to a window-shutter. The box for opaque objects is represented at HIKL: it contains a plane mirror M, for reflecting the light which it receives from the large lens to the object, and thereby illuminating it; S is a screw to adjust this mirror, or place it at a proper angle for reflecting the light. VX, two tubes of brass, one sliding within the other, the exterior one in the box HIKL; these carry the magnifying lenses: the interior tube is sometimes taken out, and the exterior one is then used by itself. Part of this tube may be seen in the plate within the box HIKL. At H there is a brass plate, the back part of which is fixed to the hollow tube *b*, in which there is a spiral wire, which keeps the plate always bearing against the side H of the brass box HIKL. The sliders, with the opaque objects, pass between this plate and the side of the box; to put them there, the plate is to be drawn back by means of the nut *g*: *ik* is a door to one side of the opaque box. The foregoing pieces constitute the several parts necessary for viewing opaque objects. We shall now proceed to describe the single microscope, which is used for transparent objects: but in order to examine these, the box HIKL must be first removed,

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and in its place we must insert the tube Y of the single Microscope that we are now going to describe.

Fig. 25. represents a large tooth-and-pinion microscope: at *m*, within the body of this microscope, are two thin plates, that are to be separated, in order to let the ivory sliders pass between them; they are pressed together by a spiral spring, which bears up the under plate, and forces it against the upper one.

The slider S (under fig. 24.), which contains the magnifiers, fits into the hole *n*; and any of the magnifiers may be placed before the object, by moving the aforesaid slider: when the magnifier is at the centre of the hole P, a small spring falls into one of the notches which is on the side of the slider.

Under the plate *m* are placed two lenses, for enlarging the field of view on the screen: the smaller of the two is fixed in a piece of brass, and is nearest the plate *m*; this is to be taken out when the magnifiers, N^o 4, 5, or 6, are used, or when the megalascope lens T (fig. 24.) is used; but is to be replaced for N^o 1, 2, 3.

This microscope is adjusted to the focus by turning the milled nut O.

To use the solar microscope:—Make a round hole in the window-shutter, a little larger than the circle *abc*; pass the mirror ONP through this hole, and apply the square plate to the shutter; then mark with a pencil the places which correspond to the two holes through which the screw is to pass; take away the microscope, and bore two holes at the marked places, sufficiently large to let the milled screws *de* pass through them.

The screws are to pass from the outside of the shutter, to go through it; and being then screwed into their respective holes in the square plate, they will, when screwed home, hold it fast against the inside of the shutter, and thus support the microscope.

Screw the conical tube ABCD to the circle *abc*, and then slide the tube G of the opaque box into the cylindrical part CD EF of the body, if opaque objects are to be examined; but if they be transparent objects you mean to show, then place the tube Y within the tube CDEF.

The room is to be darkened as much as possible, that no light may enter but what passes through the body of the microscope; for, on this circumstance, together with the brightness of the sun shine, the perfection and distinctness of the image in a great measure depend.

When the microscope is to be used for opaque objects, 1. Adjust the mirror NOP, so as to receive the solar rays, by means of the two finger screws or nuts, Q R; the first, Q, turns the mirror to the right or left; the second, R, raises or depresses it: this you are to do till you have reflected the sun's light through the lens at AB strongly upon a screen of white paper placed at some distance from the window, and formed thereon a round spot of light. An unexperienced observer will find it more convenient to obtain the light by forming this spot before he puts on either the opaque box or the tooth-and-pinion microscope.

Now put in the *opaque* box, and place the object between the plates at H; open the door *ik*, and adjust the mirror M till you have illuminated the object strongly. If you cannot effect this by the screw S,

4 Y

you

Microscope you must move the screws Q, R, in order to get the light reflected strongly from the mirror NOP, or the mirror M, without which the latter cannot illuminate the object.

The object being strongly illuminated, shut the door *ik*, and a distinct view of the object will soon be obtained on your screen, by adjusting the tubes VX, which is effected by moving them backwards or forwards.

A round spot of light cannot always be procured in northern latitudes, the altitude of the sun being often too low; neither can it be obtained when the sun is directly perpendicular to the front of the room.

As the sun is continually changing its place, it will be necessary, in order to keep his rays full upon the object, to keep them continually directed thro' the axis of the instrument, by the two screws Q and R.

To view *transparent* objects, remove the opaque box, and insert the tube Y, fig. 25. in its place; put the slider S into its place at *n*, and the slider with the objects between the plates at *m*; then adjust the mirror NOP, as before directed by the screws Q, R, so that the light may pass through the object; regulate the focus of the magnifier by the screw O. The most pleasing magnifiers in use are the fourth and fifth.

The size of the object may be increased or diminished, by altering the distance of the screen from the microscope: five or six feet is a convenient distance.

To examine transparent objects of a larger size, or to render the instrument what is usually called a *megala-scope*, take out the slider S from its place at *n*, and screw the button T (fig. 24.) into the hole at P, fig. 25. and remove the glass which is under the plate at *m*, and regulate the light and focus agreeable to the foregoing directions.

N. B. At the end of the tube G there is a lens for increasing the density of the rays, for the purpose of burning or melting any combustible or fusible substance: this lens must be removed in most cases, lest the objects should be burnt. The intensity of the light is also varied by moving this tube backwards or forwards.

Apparatus of the Opaque Solar Microscope.—The large square plate and mirror; the body of the microscope; the opaque box and its tube; the tooth-and-pinion microscope; the slider with the magnifiers; the megala-scope magnifier; the two screws *d* and *e*; some ivory sliders; some sliders with opaque objects; a brass frame, with a bottom of soft deal to stick any object on; a brass cylinder K (fig. 31.), for confining opaque objects.

IV. The CAMERA OBSCURA, or LUCERNAL, Microscope.

—The great facility with which objects can be represented on paper or a rough glass in the camera obscura, and copies drawn from them by any person though unskilled in drawing, evidently suggested the application of the microscope to this instrument. The greatest number of experiments that appear to have been made with this view, were by the late Mr Martin and Mr Adams; the former of whom frequently applied the microscope to the portable camera, and with much effect and entertainment. But these instruments being found to answer only with the assistance of the sun, Mr Adams directed his experiments to the construc-

tion of an instrument of more extended utility, which **Microscope** could be equally employed in the day-time and by night. He accordingly succeeded so far as to produce, by *candle-light*, the images of objects refracted from a single magnifier upon one or two large convex lenses (of about five inches or upwards in diameter), at the end of a pyramidal shaped box, in a very pleasing and magnified appearance, so as to give opaque objects as well as transparent ones the utmost distinctness of representation: but still the light of a candle or lamp was found generally insufficient to throw the requisite degree of illumination upon the objects. The invention of what is called *Argand's lamp*, within these few years offered a complete remedy for this defect, by the intensity and steadiness of its light. This did not escape the present Mr Adams (son of the former), who immediately applied it; and who had likewise so altered and improved his father's instrument, both in construction and form, as to render it altogether a different one, and far more perfect and useful.

The advantages and properties of this excellently conceived instrument are numerous and important. "As the far greater part of the objects which surround us are opaque (says our author), and very few are sufficiently transparent to be examined by the common microscopes, an instrument that could be readily applied to the examination of opaque objects has always been a desideratum. Even in the examination of transparent objects, many of the fine and more curious portions are lost, and drowned, as it were, in the light which must be transmitted through them; while different parts of the same object appear only as dark lines or spots, because they are so opaque as not to permit any light to pass through them. These difficulties, as well as many more, are obviated in the lucernal microscope; by which opaque objects of various sizes may be seen with ease and distinctness: the beautiful colours with which most of them are adorned, are rendered more brilliant, without changing in the least the real tint of the colour; and the concave and convex parts retain also their proper form.—The facility with which all opaque objects are applied to this instrument, is another considerable advantage, and almost peculiar to itself; as the texture and configuration of the more tender parts are often hurt by previous preparation, every object may be examined by this instrument, first as opaque, and afterwards (if the texture will admit of it) as transparent.—The lucernal microscope does not in the least fatigue that eye; the object appears like nature itself, giving ease to the sight and pleasure to the mind: there is also, in the use of this instrument, no occasion to shut the eye which is not directed to the object. A further advantage peculiar to this microscope is, that by it the outlines of every object may be taken, even by those who are not accustomed to draw; while those who can draw well will receive great assistance, and execute their work with more accuracy and in less time than they would otherwise have been able to have performed it. Transparent objects as well as opaque may be copied in the same manner. The instrument may be used at any time of the day, but the best effect is by night; in which respect it has a superiority over the solar microscope, as that instrument can only be used when the sun shines.

Microscope

Transparent objects may be examined with the lucernal microscope in three or four different modes, from a blaze of light almost too great for the eye to bear, to that which is perfectly easy to it: And by the addition of a tin lanthorn to the apparatus, may be thrown on a screen, and exhibited at one view to a large company, as by the solar microscope.

We shall now proceed to the description of the instrument and apparatus as given by Mr Adams.

Fig. 26. represents the improved *Lucernal Microscope*, mounted to view opaque objects. ABCD is a large mahogany pyramidal box, which forms the body of the microscope; it is supported firmly on the brass pillar FG, by means of the socket H and the curved piece IK.

LMN is a guide for the eye, in order to direct it in the axis of the lenses; it consists of two brass tubes, one sliding within the other, and a vertical flat piece, at the top of which is the hole for the eye. The outer tube is seen at MN, the vertical piece is represented at LM. The inner tube may be pulled out, or pushed in, to adjust it to the focus of the glasses. The vertical piece may be raised or depressed, that the hole, through which the object is to be viewed, may coincide with the centre of the field of view; it is fixed by a milled screw at M, which could not be shown in this figure.

At N is a dove-tailed piece of brass, made to receive the dove-tail at the end of the tubes MN, by which it is affixed to the wooden box ABCDE. The tubes MN may be removed from this box occasionally, for the convenience of packing it up in a less compass.

OP, a small tube which carries the magnifiers.

O, one of the magnifiers; it is screwed into the end of a tube, which slides within the tube P; the tube P may be unscrewed occasionally from the wooden body.

QRSTVX, a long square bar, which passes through the sockets YZ, and carries the stage or frame that holds the objects; this bar may be moved backward or forward, in order to adjust it to the focus by means of the pinion which is at *a*.

b, A handle furnished with an universal joint, for more conveniently turning the pinion. When the handle is removed, the nut (fig. 27.) may be used in its stead.

de, A brass bar, to support the curved piece KI, and keep the body AB firm and steady.

fghi, The stage for opaque objects: it fits upon the bar QRST by means of the socket *hi*, and is brought nearer to or removed farther from the magnifying lens by turning the pinion *a*: the objects are placed in the front side of the stage (which cannot be seen in this figure) between four small brass plates; the edges of two of these are seen at *kl*. The two upper pieces of brass are moveable; they are fixed to a plate, which is acted on by a spiral spring, that presses them down, and confines the slider with the objects: this plate, and the two upper pieces of brass, are lifted up by the small nut *m*.

At the lower part of the stage, there is a semicircular lump of glass *n*, which is designed to receive the light from the lamp, fig. 29. and to collect and throw it on the concave mirror *o*, whence it is to be reflected on the object.

The upper part *fgrs* (fig. 26.) of the opaque stage takes out, that the stage for transparent objects may be inserted in its place.

Fig. 28. represents the stage for transparent objects; the two legs 5 and 6 fit into the top of the under part *rshi* of the stage for opaque objects; 7 is the part which confines or holds the sliders, and through which they are to be moved; 9 and 10 a brass tube, which contains the lenses for condensing the light, and throwing it upon the object; there is a second tube within that, marked 9 and 10, which may be placed at different distances from the object by the pin 11.

When this stage is used as a single microscope, without any reference to the lucernal, the magnifiers, or object lenses, are to be screwed into the hole 12, and to be adjusted to a proper focus by the nut 13.

N. B. At the end AB (fig 26.) of the wooden body there is a slider, which is represented as partly drawn out at A: when quite taken out, three grooves will be perceived; one of which contains a board that forms the end of the box; the next contains a frame with a greyed glass; and the third, or that farthest from the end AB, two large convex lenses.

Fig. 29. represents one of Argand's lamps, which are the most suitable for microscopic purposes, on account of the clearness, the intensity, and the steadiness of the light. The following account of the method of managing them, with other observations, is copied from an account given by Mr Parker with those he tells.

The principle on which the lamp acts, consists in disposing the wick in thin parts, so that the air may come into contact with all the burning fuel; by which means, together with an increase of the current of air occasioned by rarefaction in the glass tube, the whole of the fuel is converted into flame.

The wicks are circular; and, the more readily to regulate the quantity of light, are fixed on a brass collar, with a wire handle, by means of which they are raised or depressed at pleasure.

To fix the wick on, a wooden mandril is contrived, which is tapered at one end, and has a groove turned at the other.

The wick has a selvage at one end, which is to be put foremost on the mandril, and moved up to the groove; then putting the groove into the collar of the wick-holder, the wick is easily pushed forward upon it.

The wick-holder and wick being put quite down in their place, the spare part of the wick should, while dry, be set a-light, and suffered to burn to the edge of the tubes; this will leave it more even than by cutting, and, being black by burning, will be much easier lighted: for this reason, the black should never be quite cut off.

The lamp should be filled an hour or two before it is wanted, that the cotton may imbibe the oil and draw the better.

The lamps which have a reservoir and valve, need no other direction for filling than to do it with a proper trimming pot, carefully observing when they are full; then pulling up the valve by the point, the reservoir, being turned with the other hand, may be replaced without spilling a drop.

Those lamps which fill in the front like a bird-fountain, must be reclined on the back to fill; and this

Microscope should be done gently, that the oil in the burner may return into the body when so placed and filled: if, by being too full, any oil appears above the guard, only move the lamp a little, and the oil will disappear; the lamp may then be placed erect, and the oil will flow to its proper level.

The oil must be of the spermaceti kind, commonly called chamber-oil, which may generally be distinguished by its paleness, transparency, and inoffensive scent: all those oils which are of a red and brown colour, and of an offensive scent, should be carefully avoided, as their glutinous parts clog the lamp, and the impurities in such oil, not being inflammable, will accumulate and remain in the form of a crust on the wick. Seal oil is nearly as pale and sweet as chamber oil; but being of a heavy sluggish quality, is not proper for lamps with fine wicks.

Whenever bad oil has been used, on changing it, the wick must also be changed; because, after having imbibed the coarse particles in its capillary tubes, it will not draw up the fine oil.

To obtain the greatest degree of light, the wick should be trimmed exactly even, the flame will then be completely equal.

There will be a great advantage in keeping the lamp clean, especially the burner and air-tubes; the neglect of cleanliness in lamps is too common: a candlestick is generally cleaned every time it is used, so should a lamp; and if a candlestick is not to be objected to because it does not give light after the candle is exhausted, so a lamp should not be thought ill of, if it does not give light when it wants oil or cotton; but this last has often happened, because the deficiency is less visible.

The glass tubes are best cleaned with a piece of wash leather.

If a fountain-lamp is left partly filled with oil, it may be liable to overflow; this happens by the contraction of the air when cold, and its expansion by the warmth of a room, the rays of the sun, or the heat of the lamp when re-lighted: this accident may be effectually prevented by keeping the reservoir filled, the oil not being subject to expansion like air. On this account, those with a common reservoir are best adapted for microscopic purposes.

To examine Opaque Objects with the Lucernal Microscope. To render the use of this instrument easy, it is usually packed with as many of the parts together as possible: it occupies on this account rather more room, but is much less embarrassing to the observer, who has only three parts to put on after it is taken out of its box, namely, the guide for the eye, the stage, and the tube with its magnifier.

But to be more particular: Take out the wooden slider A (fig. 26.), then lift out the cover and the grey glass from their respective grooves under the slider A.

Put the end N of the guide for the eye LMM into its place, so that it may stand in the position which is represented in this figure.

Place the socket which is at the bottom of the opaque stage, on the bar QXT, so that the concave mirror *o* may be next the end DE of the wooden body.

Screw the tubes PO into the end DE. The mag-*Microscope* nifier you intend to use is to be screwed on the end O of these tubes.

The handle Gb, or the milled nut fig. 27. must be placed on the square end of the pinion *a*.

Place the lamp lighted before the glass lump *n*, and the object you intend to examine between the spring-plates of the stage; and the instrument is ready for use.

In all microscopes there are two circumstances which must be particularly attended to: first, the modification of the light, or the proper quantity to illuminate the object; secondly, the adjustment of the instrument to the focus of the glasses and eye of the observer. In the use of the lucernal microscope there is a third circumstance, which is, the regulation of the guide for the eye.

1. To throw the light upon the object. The flame of the lamp is to be placed rather below the centre of the glass lump *n*, and as near it as possible; the concave mirror *o* must be so inclined and turned as to receive the light from the glass lump, and reflect it thence upon the object; the best situation of the concave mirror and the flame of the lamp depends on a combination of circumstances, which a little practice will discover.

2. To regulate the guide for the eye, or to place the centre of the eye-piece L so that it may coincide with the focal point of the lenses and the axis of vision: Lengthen and shorten the tubes MN, by drawing out or pushing in the inner tube, and raising or depressing the eye-piece ML, till you find the large lens (which is placed at the end AB of the wooden body) filled by an uniform field of light, without any prismatic colours round the edge; for till this piece is properly fixed, the circle of light will be very small, and only occupy a part of the lens: the eye must be kept at the centre of the eye-piece L, during the whole of the operation; which may be rendered somewhat easier to the observer, on the first use of the instrument, if he hold a piece of white paper parallel to the large lens, removing it from or bringing it nearer to them till he find the place where a lucid circle, which he will perceive on the paper, is brightest and most distinct; then he is to fix the centre of the eye-piece to coincide with that spot; after which a very small adjustment will set it perfectly right.

3. To adjust the lenses to their focal distance. This is effected by turning the pinion *a*, the eye being at the same time at the eye-piece L. The grey glass is often placed before the large lenses, while regulating the guide for the eye, and adjusting for the focal distance.

If the observer, in the process of his examination of an object, advance rapidly from a shallow to a deep magnifier, he will save himself some labour by pulling out the internal tube at O.

The upper part *fgrs* of the stage is to be raised or lowered occasionally, in order to make the centre of the object coincide with the centre of the lens at O.

To delineate objects, the grey glass must be placed before the large lenses; the picture of the object will be formed on this glass, and the outline may be accurately taken by going over the picture with a pencil.

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Fig. 26.

Fig. 29.

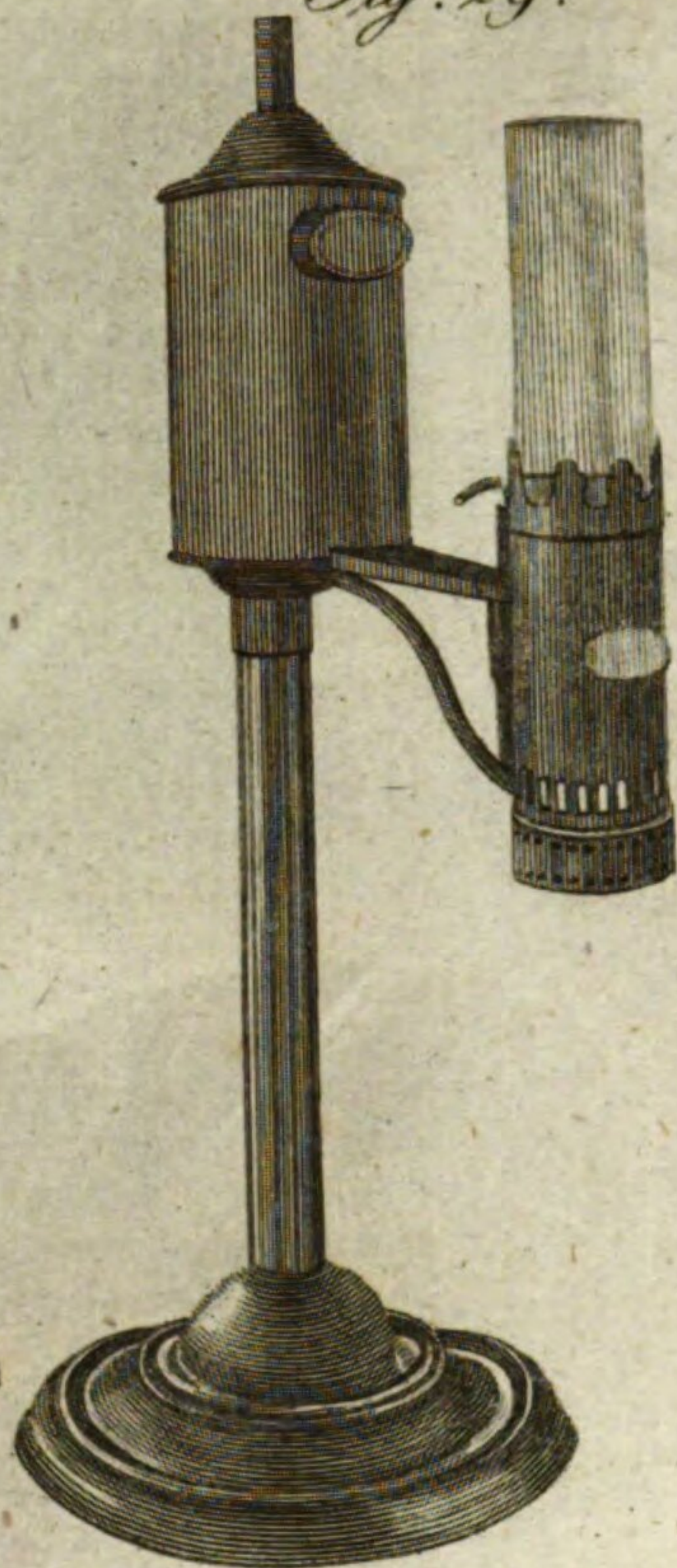
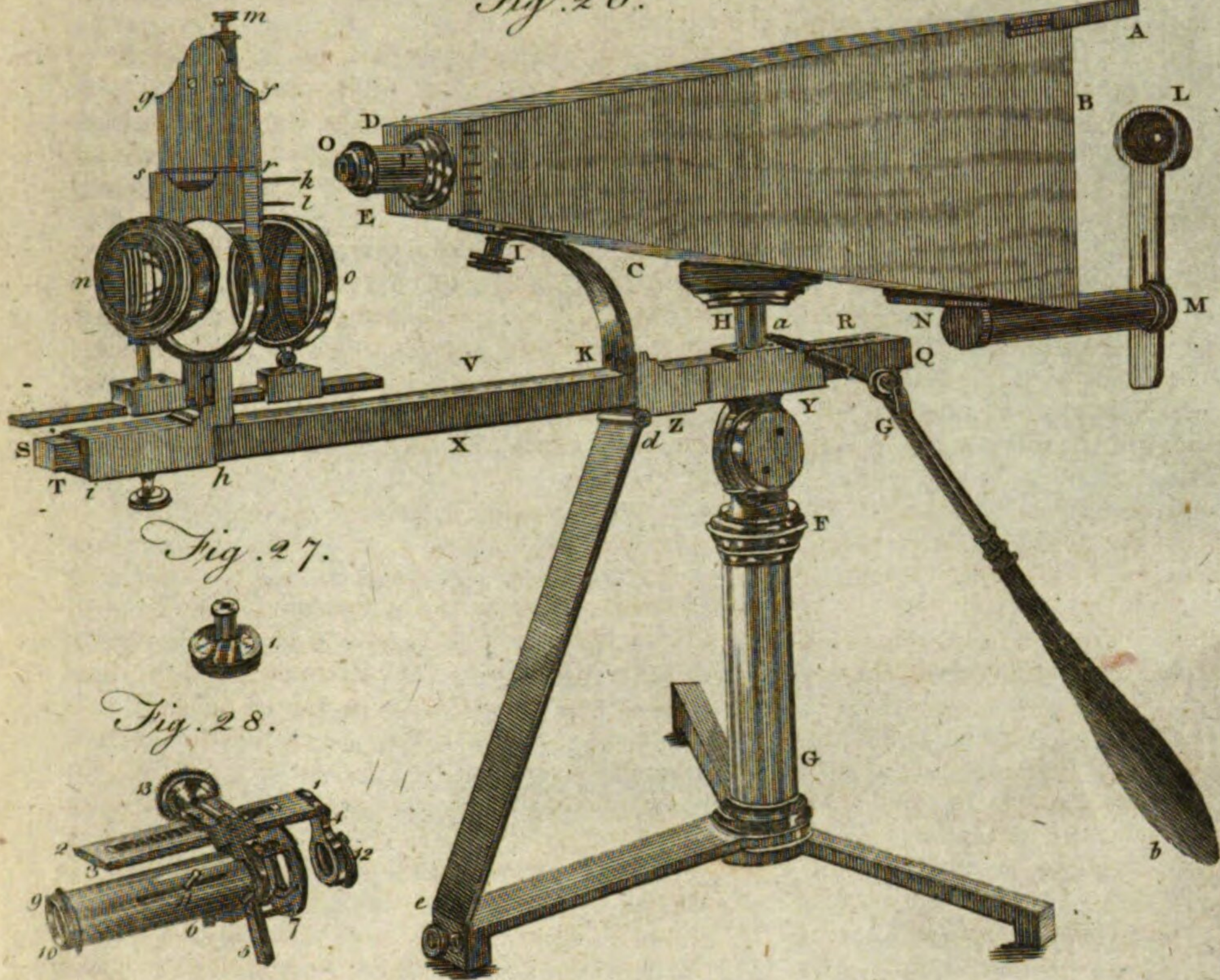


Fig. 27.

Fig. 28.

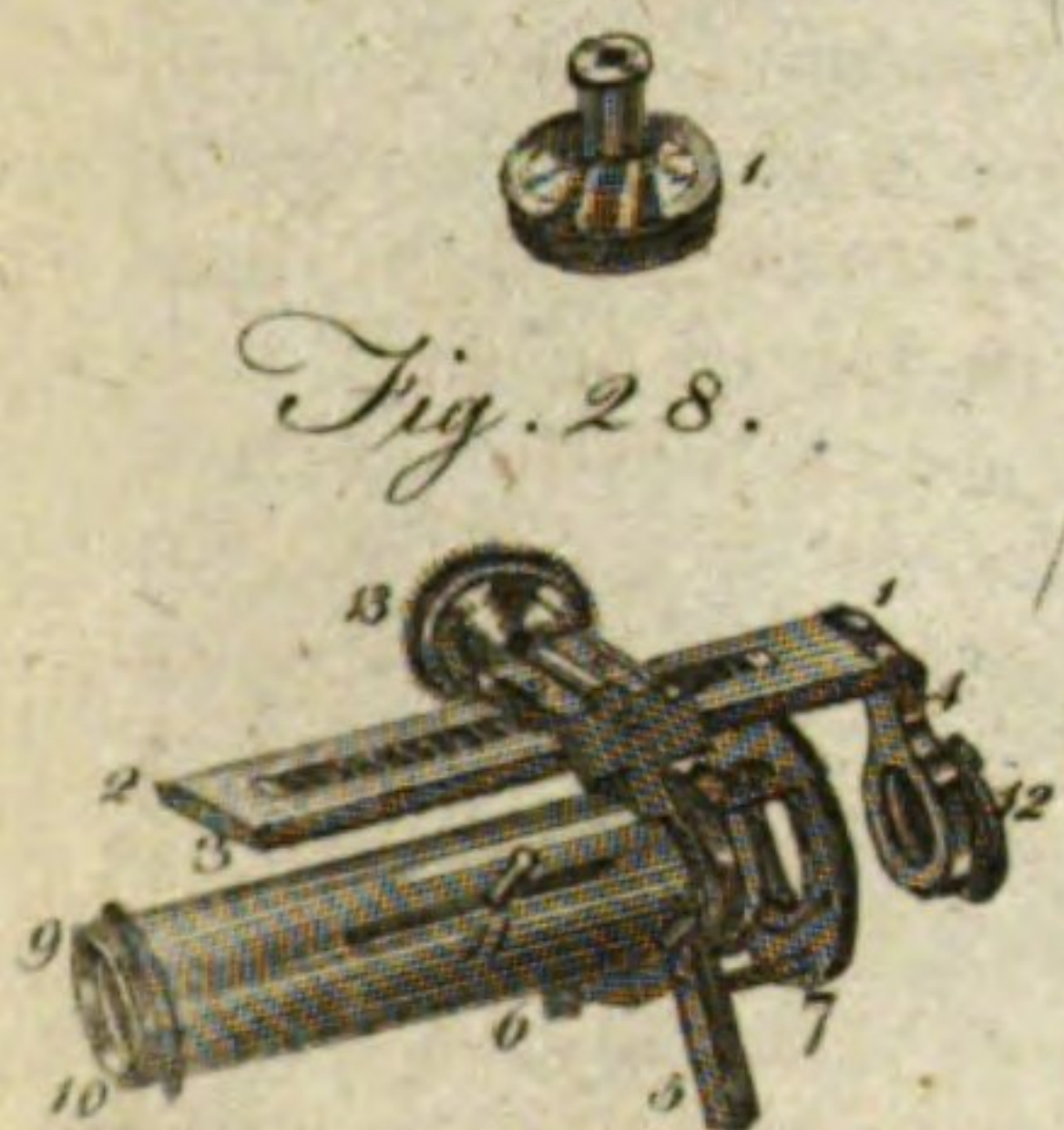
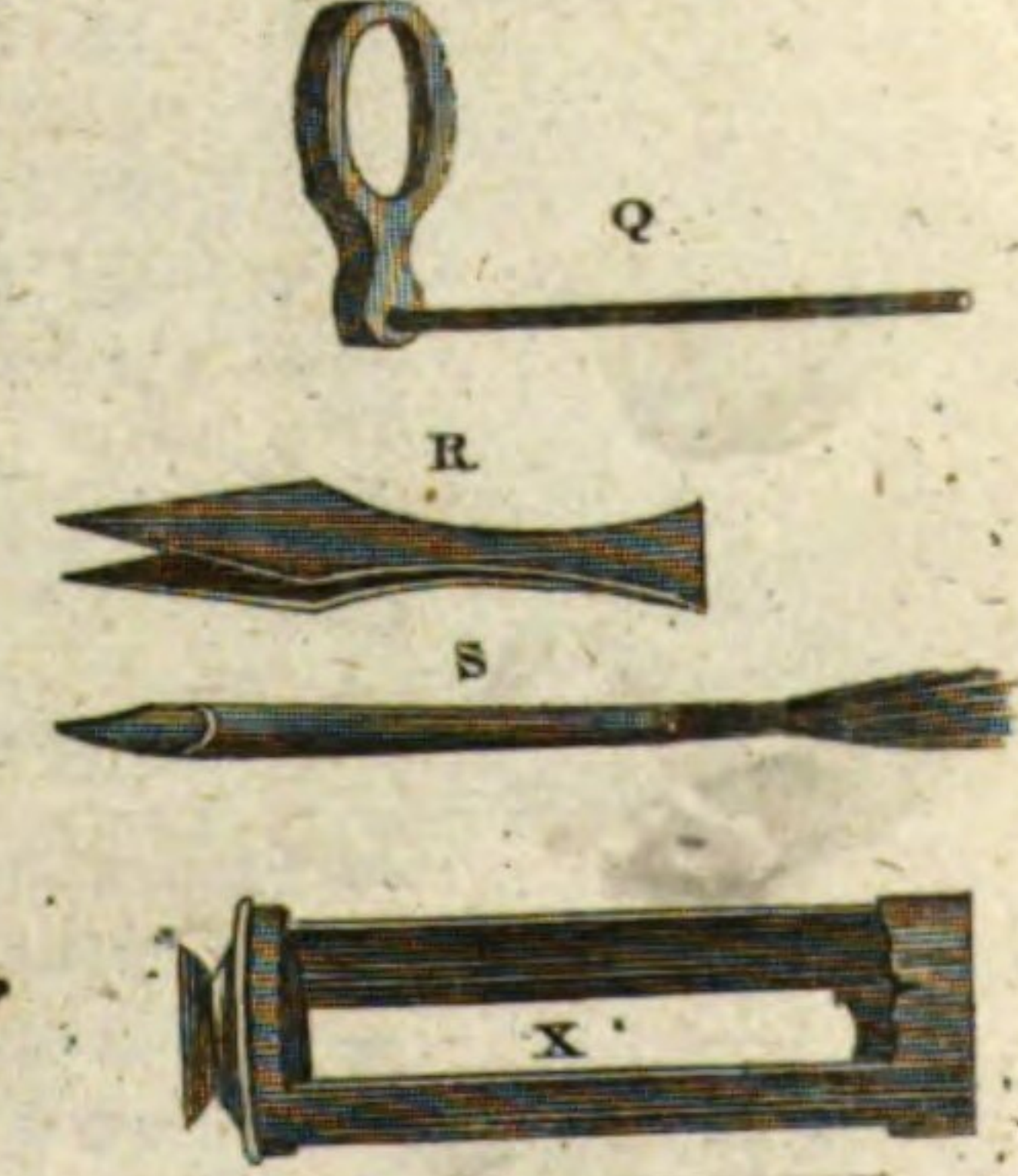
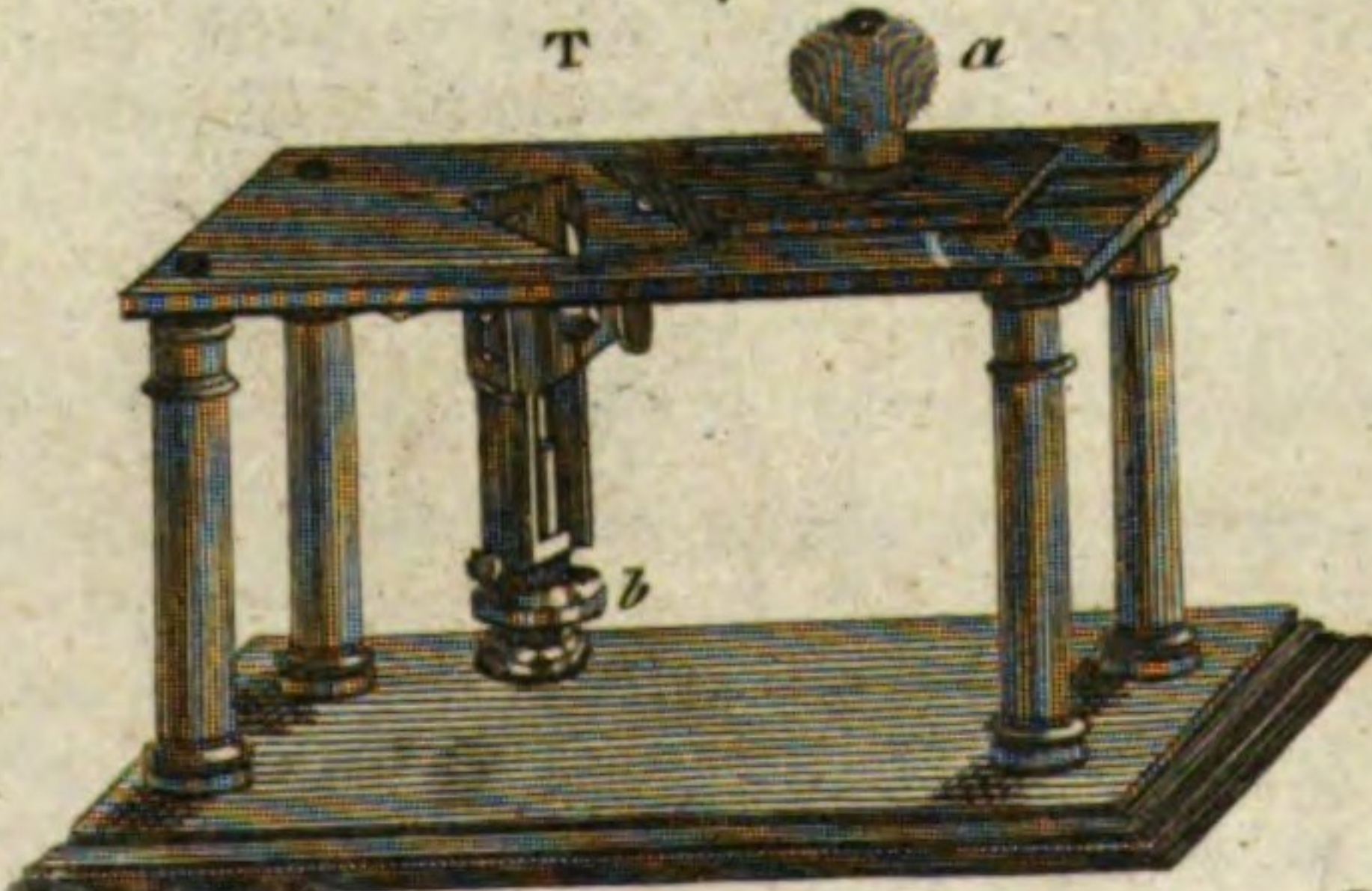
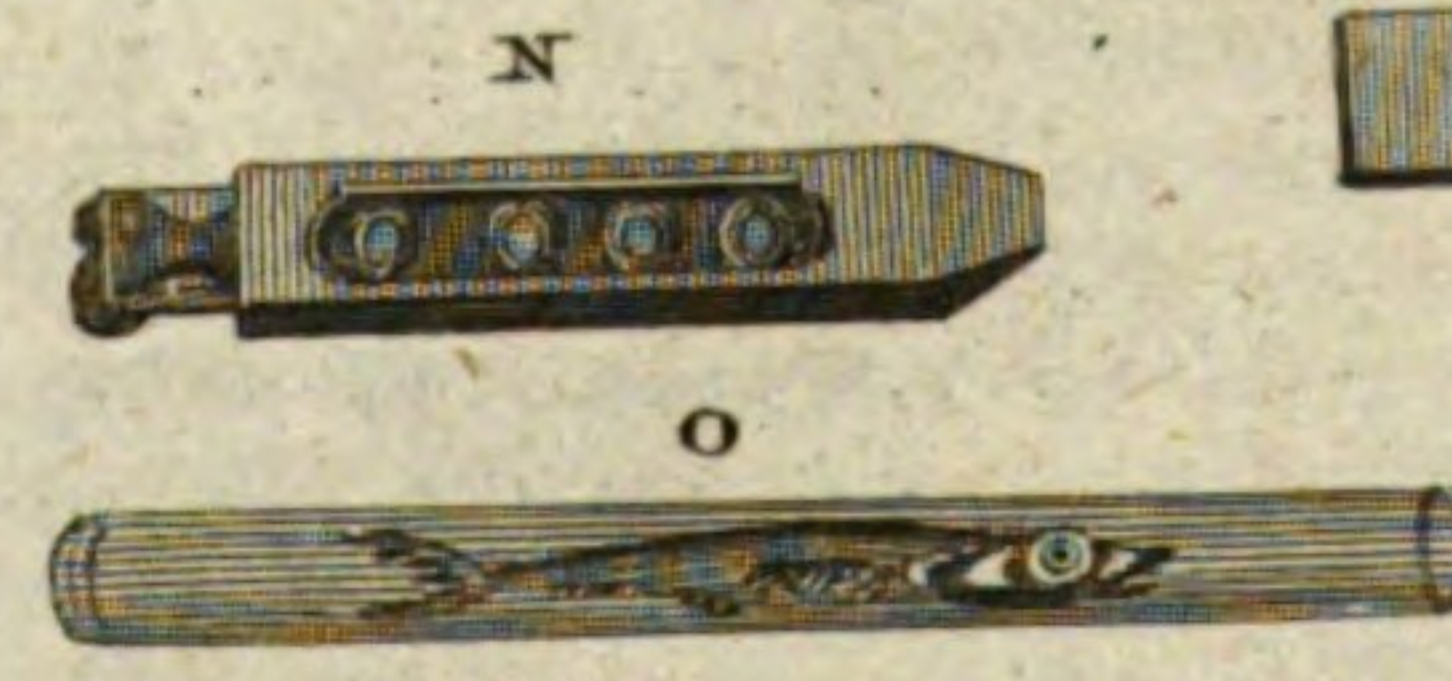
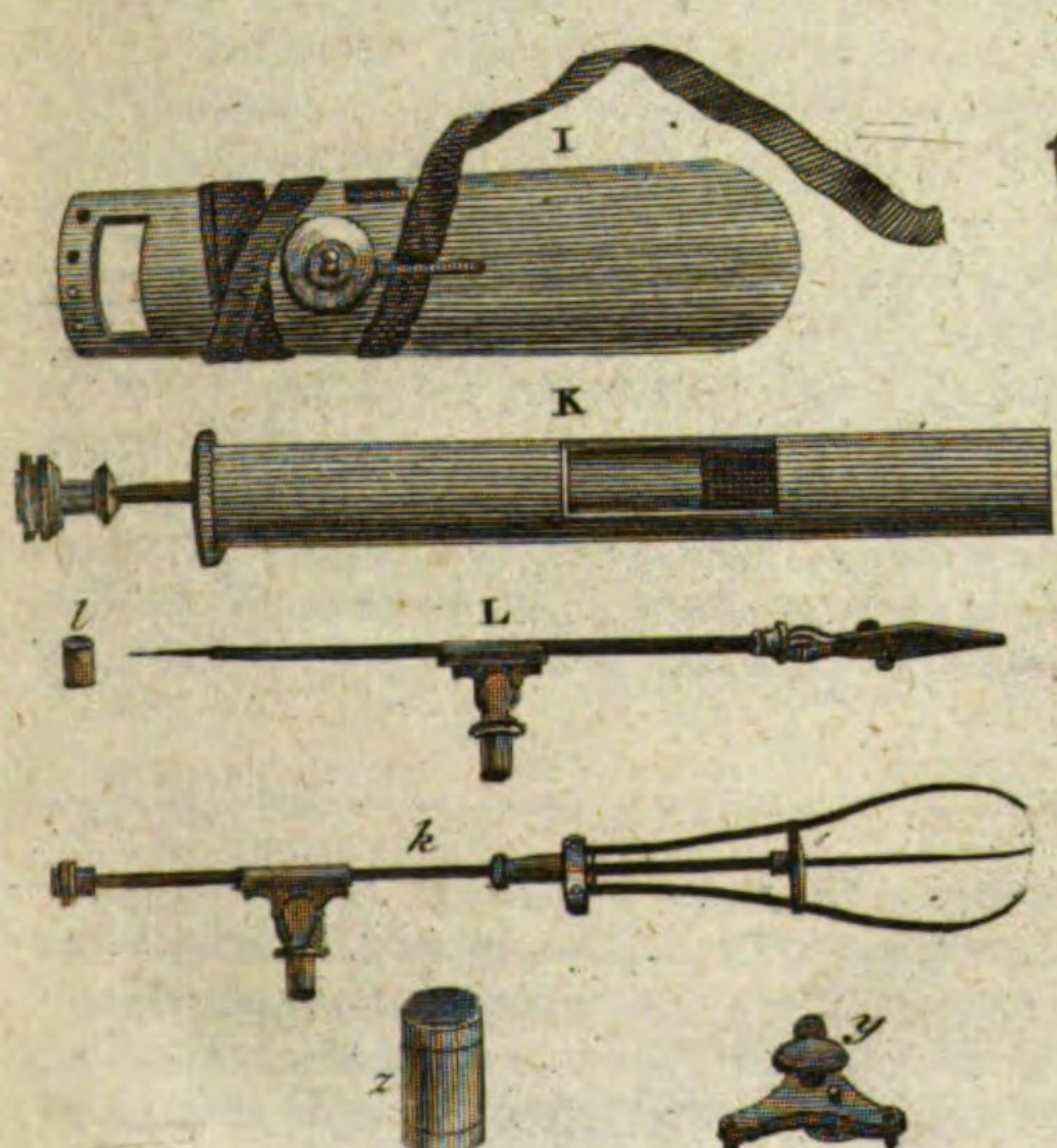
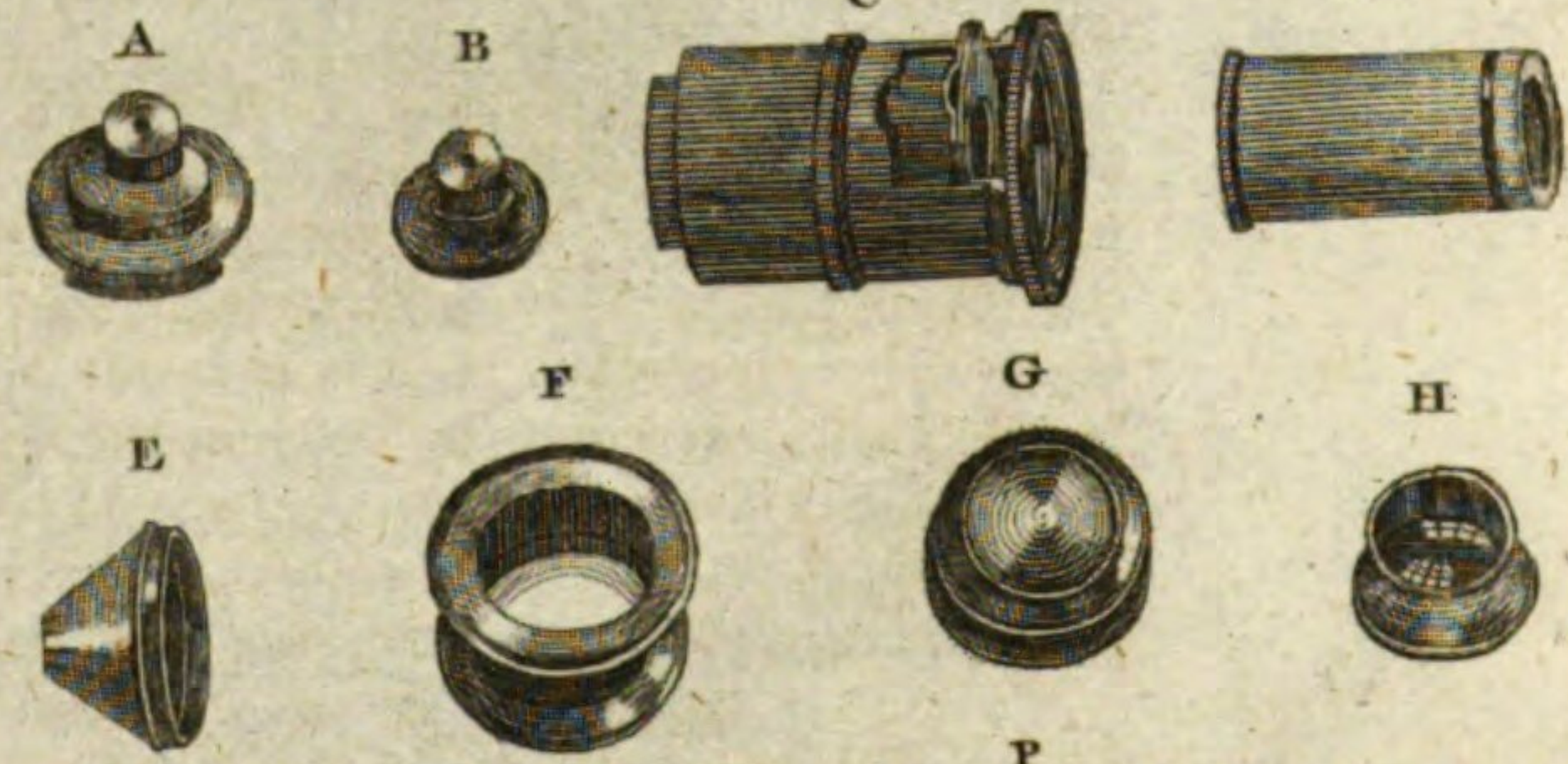
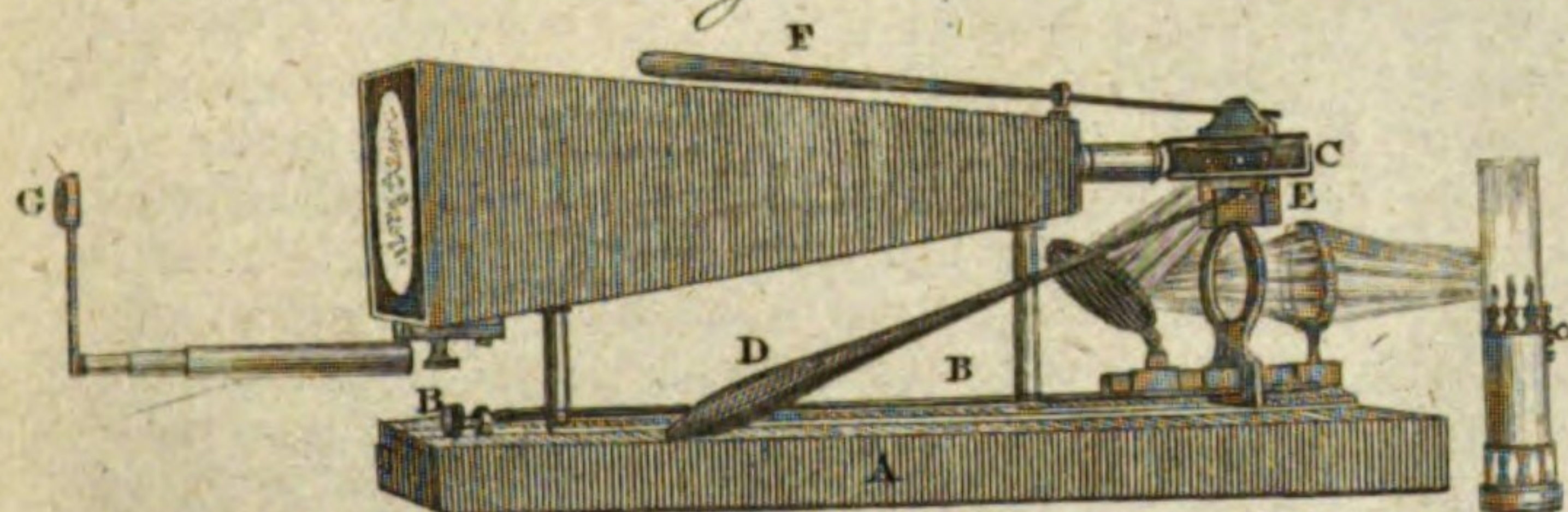


Fig. 30.

Fig. 31.



Microscope

Microscope

The opaque part may be used in the day-time without a lamp, provided the large lenses at AB are screened from the light.

To use the Lucernal Microscope in the examination of Transparent Objects. The instrument is to remain as before: the upper part *fgs* of the opaque stage must be removed, and the stage for transparent objects, represented at fig. 28. put in its place; the end *g 10* to be next the lamp.

Place the greyed glass in its groove at the end AB, and the objects in the slider holder at the front of the stage; then transmit as strong a light as you are able on the object, which you will easily do by raising or lowering the lamp.

The object will be beautifully depicted on the grey glass: it must be regulated to the focus of the magnifier, by turning the pinion *a*.

The object may be viewed either with or without the guide for the eye. A single observer will see an object to the greatest advantage by using this guide, which is to be adjusted as we have described above. If two or three wish to examine the object at the same time, the guide for the eye must be laid aside.

Take the large lens out of the groove, and receive the image on the grey glass; in this case, the guide for the eye is of no use: if the grey glass be taken away, the image of the object may be received on a paper screen.

Take out the grey glass, replace the large lenses, and use the guide for the eye; attend to the foregoing directions, and adjust the object to its proper focus. You will then see the object in a blaze of light almost too great for the eye, a circumstance that will be found very useful in the examination of particular objects. The edges of the object in this mode will be somewhat coloured: but as it is only used in this full light for occasional purposes, it has been thought better to leave this small imperfection, than, by remedying it, to sacrifice greater advantages; the more so, as this fault is easily corrected, and a new and interesting view of the object is obtained, by turning the instrument out of the direct rays of light, and permitting them to pass through only in an oblique direction, by which the upper surface is in some degree illuminated, and the object is seen partly as opaque, partly as transparent. It has been already observed, that the transparent objects might be placed between the slider-holders of the stage for opaque objects, and then be examined as if opaque.

Some transparent objects appear to the greatest advantage when the lens at *g 10* is taken away; as, by giving too great a quantity of light, it renders the edges less sharp.

The variety of views which may be taken of every object by means of the improved lucernal microscope, will be found to be of great use to an accurate observer: it will give him an opportunity of correcting or

confirming his discoveries, and investigating those parts in one mode which are invisible in another.

To throw the image of transparent objects on a screen, as in the solar microscope. It has been long a microscopical desideratum, to have an instrument by which the image of transparent objects might be thrown on a screen, as in the common solar microscope: and this not only because the sun is so uncertain in this climate, and the use of the solar microscope requires confinement in the finest part of the day, when time seldom hangs heavy on the mind; but as it also affords an increase of pleasure, by displaying its wonders to several persons at the same instant, without the least fatigue to the eye.

This purpose is now effectually answered, by affixing the transparent stage of the lucernal to a lanthorn, with one of Argand's lamps.—The lamp is placed within the lanthorn, and the end *g 10* of the transparent stage is screwed into a female screw, which is rivetted in the sliding part of the front of the lanthorn; the magnifying lenses are to be screwed into the hole represented at *12*, and they are adjusted by turning the milled nut. The quantity of light is to be regulated by raising and lowering the sliding-plate or the lamp.

Apparatus which usually accompanies the improved Lucernal Microscope. The stage for opaque objects, with its semicircular lump of glass, and concave mirror. The stage for transparent objects, which fits on the upper part of the foregoing stage. The sliding tube, to which the magnifiers are to be affixed: one end of these is to be screwed on the end D of the wooden body; the magnifier in use is to be screwed to the other end of the inner tube. Eight magnifying lenses: these are so constructed, that they may be combined together, and thus produce a very great variety of magnifying powers. A fish-pan, such as is represented at I. A steel wire L, with a pair of nippers at one end, and a small cylinder of ivory / at the other. A slider of brass N, containing a flat glass slider, and a brass slider into which are fitted some small concave glasses. A pair of forceps. Six large and six small ivory sliders, with transparent objects. Fourteen wooden sliders, with four opaque objects in each slider; and two spare sliders. Some capillary tubes for viewing small animalcula.

Ingenious men seldom content themselves with an instrument under one form; hence such a variety of microscopes, hence many alterations in the Lucernal Microscope. Mr Adams himself, we understand, has fitted up this last in a great many different ways; and it is reasonable to think that no person is more likely to give it every improvement of which it is susceptible. Of the alterations by other hands we shall only particularise one, made by Mr Jones of Holborn (B), whose description is as follows:

A, represents a portion of the top of the mahogany box

box

(B) We trust the reader will never consider any paragraph wherein the name of an instrument-maker or other artist is inserted, as a recommendation of those artists by the editors of this work. In the course of a pretty extensive correspondence, they have been favoured with very liberal communications from various artists, for which they are greatly indebted to them: the inserting their names in this work is therefore to be considered as a grateful acknowledgment from the editors for favours conferred on them,—not as a testimonial

Microscope box in which it packs, to preserve it steady; it slides in a dove-tail groove within, a similar groove to which is cut in the top of the box A; so that when the instrument is to be used, it is slipped out of the box within, and then slipped into the groove at top ready for use, almost instantly, as shown in the figure. The adjustment of the objects is at the stage E; for the right focal distance is readily and conveniently made by turning the long screw-rod BB, which goes thro' the two pillars supporting the box, and works in the base of the brass stage E; which base is also dove-tailed, so as to have a regular and steady motion in another brass basis that supports it. In this instrument, therefore, the pyramideal box does not move; but the stage part only, which, from its small weight, moves in the most agreeable and steady manner. While observing the image of the object upon the glass through the sight-hole at G, the object may be moved or changed by only turning the rack-work and pinion applied to the stage, by means of the handle D, for that purpose. By this contrivance you have no occasion to change your position during the view of the objects upon one of the sliders. This motion changes the objects horizontally only; and as they are generally placed exactly in one line, it answers all the purposes for which this motion is intended very well. But it may sometimes happen that the observer would wish to alter the vertical position of the object; to perform which there is another plane rod at F, that acts simply as a lever for this purpose, and moves the sliding part of the stage E vertically either upwards or downwards.

Thus, without altering his position, the observer may investigate all parts of the objects in the most satisfactory manner. Rack-work and pinion might be applied to the stage for the vertical motion also; but as it would materially enhance the expence, it is seldom applied. The brass work at the handle of D contains a Hooke's universal joint.

The brilliancy of the images of the objects shown upon the large lenses at the end of the box, being very frequently so great as to dazzle the eyes, Mr Jones applies a slight tinge of blue, green, and other coloured glass, to the sight-hole at G, which softens this glare, and casts an agreeable hue upon the objects.

Description of those Parts of a Microscopical Apparatus, common to most Instruments, which are delineated at fig. 31.

A and B represent the brass cells which contain the magnifiers belonging to the different kinds of compound microscopes. The magnifiers are sometimes contained in a slider like that which is delineated at S (fig. 24). The lenses of A and B are confined by a small cap; on unscrewing this, the small lens may be taken out and cleaned. The magnifiers A of the lucernal microscope are so contrived, that any two of them may be screwed together, by which means a considerable variety of magnifying power is obtained.

To get at the lenses in the slider S (fig. 24.), take out the two screws which hold on the cover.

Microscope C, represents the general form of the slider-holder. It consists of a cylindrical tube, in which an inner tube is forced up by a spring. It is used to receive the ivory or any other slider, in which the transparent objects are placed; these are to be slid between the two upper plates: the hollow part in one of the plates is designed for the glass tubes.

D, the condensing lens and its tube, which fits into the slider-holder C, and may be moved up and down in it. When this piece is pushed up as far as it will go, it condenses the light of a candle, which is reflected on it by the plain mirror of the compound microscope, and spreads it uniformly over the object; in this case it is best adapted to the shallowest magnifiers. If the deeper lenses are used, it should be drawn down, or rather removed further from the object, that it may concentrate the light in a small compass, and thus render it more dense. The condensing lens is sometimes fitted up differently; but the principle being the same, it will be easy to apply it to use notwithstanding some variations in the mechanism.

E, a brass cone. It fixes under the slider-holder, and is used to lessen occasionally the quantity of light which comes from the mirror to any object.

F, a box with two flat glasses, which may be placed at different distances from each other in order to confine a small living insect.

G, a small brass box to hold the silver speculum H.

H, a small silver concave speculum, designed to reflect the light from the mirror on opaque objects; it should only be used with the shallow magnifiers. It is applied in different ways to the compound microscope; sometimes to a tube similar to that represented at X, which slides on the lower part of the body; sometimes it is screwed into the ring of the piece Q; the pin of this generally fits into one of the holes in the stage. When this speculum is used, the slider-holder should be removed.

I, a fish-pan, whereon a small fish may be fastened, in order to view the circulation of the blood: its tail is to be spread across the oblong hole at the smallest end, and tied fast by means of the ribbon fixed thereto, by shoving the knob which is on the back of it through the slit made in the stage; the tail of the fish may be brought under the lens which is in use.

K, a cylindrical piece, intended for the solar opaque microscope: by pulling back the spiral spring, smaller or larger objects may be confined in it.

L, A pair of triangular nippers for taking hold of and confining a large object.

M, a long steel wire, with a small pair of pliers at one end and a steel point at the other: the wire slips backwards or forwards in a spring tube, which is affixed to a joint, at the bottom of which is a pin to fit one of the holes in the stage; this piece is used to confine small objects.

N, A small ivory cylinder that fits on the pointed end of the steel wire L; it is designed to receive opaque objects. Light-coloured ones are to be stuck on the dark side, and *vice versa*.

O, a convex lens, which fits to the stage by means of

nial of their opinion of the abilities of an individual, or as designed to insinuate any preference over others in the same line, where such preference has not been already bestowed by the public.

Microscope of the long pin adhering to it. This piece is designed to collect the light from the sun or a candle, and to throw them on any object placed on the stage; but it is very little used at present.

N, a brass slider, into which is fitted a flat piece of glass, and a brass slider containing four small glasses, one or two of them concave, the others flat; it is designed to confine small living objects, and when used is to be placed between the two upper plates of the slider-holder.

O, a glass tube to receive a small fish, &c.

P, represents one of the ivory sliders, wherein objects are placed between two pieces of talc, and confined by a brass ring.

Q, a piece to hold the speculum H: this piece is generally fitted to the microscope represented at fig. 12.

R, a pair of forceps, to take up any occasional object.

S, a camel's hair pencil to brush the dust off the glasses; the upper part of the quill is scooped out, to take up a drop of any fluid, and place it on either of the glasses for examination.

T, an instrument for cutting thin transverse sections of wood. It consists of a wooden base, which supports four brass pillars; on the top of the pillars is placed a flat piece of brass, near the middle of which there is a triangular hole.

A sharp knife, which moves in a diagonal direction, is fixed on the upper side of the afore-mentioned plate, and in such a manner that the edge always coincides with the surface thereof.

The knife is moved backwards and forwards by means of the handle *a*. The piece of wood is placed in the triangular trough which is under the brass plate, and is to be kept steady therein by a milled screw which is fitted to the trough; the wood is to be pressed forward for cutting by the micrometer screw *b*.

The pieces of wood should be applied to this instrument immediately on being taken out of the ground, or else they should be soaked for some time in water, to soften them, so that they may not hurt the edge of the knife.

When the edge of the knife is brought in contact with the piece of wood, a small quantity of spirits of wine should be poured on the surface of the wood, to prevent its curling up; it will also make it adhere to the knife, from which it may be removed by pressing a piece of blotting paper on it.

y, An appendage to the cutting engine, which is to be used instead of the micrometer screw, being preferred to it by some. It is placed over the triangular hole, and kept flat down upon the surface of the brass plate, while the piece of wood is pressed against a circular piece of brass which is on the under side of it. This circular piece of brass is fixed to a screw, by which its distance from the flat plate on which the knife moves may be regulated.

z, An ivory box, containing at one end spare talc for the ivory sliders, and at the other spare rings for pressing the talcs together and confining them to the slider.

AFTER what has been related of Microscopes, they cannot be said to be complete without the valuable

addition of a *micrometer*; for the use and advantages of which, see the article MICROMETER.

HAVING presented our readers with descriptions of the various microscopes generally used, we think it our duty to point out to them those which we conceive to be best calculated to answer the purposes of science. The first which presents itself to our mind is that of *Ellis*: It is better adapted, than any other portable microscope, to the purpose of general observation; simple in its construction, and general in its application. To those who prefer a double microscope, we should recommend that figured in Plate CCXCVIII. (12.) If opaque objects, as insects, &c. be subjects of investigation, the *Lucernal Microscope* claims the preference: but if amusement alone guides the choice, the *Solar Microscope* must be fixed upon.

WE shall now proceed to explain some necessary particulars respecting the method of using microscopes; after which, we shall subjoin an enumeration of the principal objects discovered or elucidated by their means. On this subject Mr Adams, in his *Essay on the Microscope*, has been very copious; with a view, as he informs us, to remove the common complaint made by Mr Baker, "that many of those who purchase microscopes are so little acquainted with their general and extensive usefulness, and so much at a loss for objects to examine by them, that after diverting their friends some few times with what they find in the sliders which generally accompany the instrument, or perhaps with two or three common objects, the microscope is laid aside as of little further value; whereas no instrument has yet appeared in the world capable of affording so constant, various, and satisfactory an entertainment to the mind."

I. In using the microscope, there are three things necessary to be considered. (1.) The preparation and adjustment of the instrument itself. (2.) The proper quantity of light, and the best method of adapting it to the object. (3.) The method of preparing the objects, so that their texture may be properly understood.

1. With regard to the microscope itself, the first thing necessary to be examined is, whether the glasses be clean or not: if they are not so, they must be wiped with a piece of soft leather, taking care not to soil them afterwards with the fingers; and, in replacing them, care must be taken not to place them in an oblique situation. We must likewise be careful not to let the breath fall upon the glasses, nor to hold that part of the body of the instrument where the glasses are placed with a warm hand; because thus the moisture expelled by the heat from the metal will condense upon the glass, and prevent the object from being distinctly seen. The object should be brought as near the centre of the field of view as possible; for there only it will be exhibited in the greatest perfection. The eye should be moved up and down from the eye-glass of a compound microscope, till the situation is found where the largest field and most distinct view of the object are to be had: but every person ought to adjust the microscope to his own eye, and not to depend upon the situation it was placed in by another. A small magnifying power should

always

Microscope always be begun with; by which means the observer will best obtain an exact idea of the situation and connection of the whole; and will of consequence be less liable to form any erroneous opinion when the parts are viewed separately by a lens of greater power. Objects should also be examined first in their most natural position: for if this be not attended to, we shall be apt to form very inadequate ideas of the structure of the whole, as well as of the connection and use of the parts. A living animal ought to be as little hurt or discomposed as possible.

From viewing an object properly, we may acquire a knowledge of its nature: but this cannot be done without an extensive knowledge of the subject, much patience, and many experiments; as in a great number of cases the images will resemble each other, though derived from very different substances. Mr Baker therefore advises us not to form an opinion too suddenly after viewing a microscopical object; nor to draw our inferences till after repeated experiments and examinations of the object in many different lights and positions; to pass no judgment upon things extended by force, or contracted by dryness, or in any manner out of a natural state, without making suitable allowances. The true colour of objects cannot be properly determined by very great magnifiers; for as the pores and interstices of an object are enlarged according to the magnifying power of the glasses made use of, the component particles of its substance will appear separated many thousand times farther asunder than they do to the naked eye: hence the reflection of the light from these particles will be very different, and exhibit different colours. It is likewise somewhat difficult to observe opaque objects; and as the apertures of the larger magnifiers are but small, they are not proper for the purpose. If an object be so very opaque, that no light will pass through it, as much as possible must be thrown upon the upper surface of it. Some consideration is likewise necessary in forming a judgment of the motion of living creatures, or even of fluids, when seen through the microscope; for as the moving body, and the space wherein it moves, are magnified, the motion will also be increased.

2. On the management of the light depends in a great measure the distinctness of the vision: and as, in order to have this in the greatest perfection, we must adapt the quantity of light to the nature of the object and the focus of the magnifier, it is therefore necessary to view it in various degrees of light. In some objects, it is difficult to distinguish between a prominence and a depression, a shadow or a black stain; or between a reflection of light and whiteness, which is particularly observable in the eye of the libella and other flies: all of these appearing very different in one position from what they do in another. The brightness of an object likewise depends on the quantity of light, the distinctness of vision, and on regulating the quantity to the object; for some will be in a manner lost in a quantity of light scarce sufficient to render another visible.

There are various ways in which a strong light may be thrown upon objects; as by means of the sun and a convex lens. For this purpose, the microscope is to be placed about three feet from a southern window;

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then take a deep convex lens, mounted on a semicircle and stand, so that its position may easily be varied: place this lens between the object and the window, so that it may collect a considerable number of solar rays, and refract them on the object or the mirror of the microscope. If the light thus collected from the sun be too powerful, it may be lessened by placing a piece of oiled paper, or a piece of glass lightly greyed, between the object and lens. Thus a proper degree of light may be obtained, and diffused equally all over the surface of an object: a circumstance which ought to be particularly attended to; for if the light be thrown irregularly upon it, no distinct view can be obtained. If we mean to make use of the solar light, it will be found convenient to darken the room, and to reflect the rays of the sun on the abovementioned lens by means of the mirror of a solar microscope fixed to the window-shutter; for thus the observer will be enabled to preserve the light on his object, notwithstanding the motion of the sun. But by reason of this motion, and the variable state of the atmosphere, solar observations are rendered both tedious and inconvenient; whence it will be proper for the observer to be furnished with a large tin lanthorn, formed something like the common magic lanthorn, capable of containing one of Argand's lamps. This, however, ought not to be of the fountain kind, lest the rarefaction of the air in the lanthorn should force the oil over. There ought to be an aperture in the front of the lanthorn, which may be moved up and down, and be capable of holding a lens; by which means a pleasant and uniform as well as strong light may easily be procured. The lamp should likewise move on a rod, so that it may be easily raised or depressed. This lanthorn may likewise be used for many other purposes; as viewing of pictures, exhibiting microscopic objects on a screen, &c. A weak light, however, is best for viewing many transparent objects: among which we may reckon the prepared eyes of flies, as well as the animalcules in fluids. The quantity of light from a lamp or candle may be lessened by removing the microscope to a greater distance from them, or by diminishing the strength of the light which falls upon the objects. This may very conveniently be done by pieces of black paper with circular apertures of different sizes, and placing a larger or smaller one upon the reflecting mirror, as occasion may require. There is an oblique situation of the mirrors, which makes likewise an oblique reflection of the light easily discovered by practice, (but for which no general rule can be given in theory); and which will exhibit an object more distinctly than any other position, showing the surface, as well as those parts through which the light is transmitted. The light of a lamp or candle is generally better for viewing microscopic objects than day-light; it being more easy to modify the former than the latter, and to throw it upon the objects with different degrees of density.

3. With regard to the preparation of objects, Swammerdam has, in that particular, excelled almost all other investigators who either preceded or have succeeded him. He was so assiduous and indefatigable, that neither difficulty nor disappointment could make the least impression upon him; and he never abandoned the pursuit of any object until he had obtained

Microscope tained a satisfactory idea of it. Unhappily, however, the methods he made use of in preparing his objects for the microscope are now entirely unknown. Dr Boerhaave examined with the strictest attention all the letters and manuscripts of Swammerdam which he could find; but his researches were far from being successful. The following particulars, however, have thus come to the knowledge of the public.

For dissecting of *small insects*, Swammerdam had a brass table made by S. Muschenbroek, to which were affixed two brass arms moveable at pleasure to any part of it. The upper part of these vertical arms was constructed in such a manner as to have a slow vertical motion; by which means the operator could readily alter their height as he saw convenient. One of these arms was to hold the minute objects, and the other to apply the microscope.

The lenses of Swammerdam's microscopes were of various sizes as well as foci: but all of them the best that could be procured, both for the transparency of the glass and the fineness of the workmanship. His observations were always begun with the smallest magnifiers, from which he proceeded to the greatest; but in the use of them, he was so exceedingly dexterous, that he made every observation subservient to that which succeeded it, and all of them to the confirmation of each other, and to the completing of the description. His chief art seems to have been in constructing scissars of an exquisite fineness, and making them very sharp. Thus he was enabled to cut very minute objects to much more advantage than could be done by knives and lancets; for these, though ever so sharp and fine, are apt to disorder delicate substances by displacing some of the filaments, and drawing them after them as they pass through the bodies; but the scissars cut them all equally. The knives, lancets, and styles he made use of in his dissections, were so fine that he could not see to sharpen them without the assistance of a magnifying glass; but with these he could dissect the intestines of bees with the same accuracy that the best anatomists can do those of large animals. He made use also of very small glass tubes no thicker than a bristle, and drawn to a very fine point at one end, but thicker at the other. These were for the purpose of blowing up, and thus rendering visible the smallest vessels which could be discovered by the microscope; to trace their courses and communications, or sometimes to inject them with coloured liquors.

Swammerdam sometimes made use of spirit of wine, water, or oil of turpentine, for suffocating the insects he wished to examine; and would preserve them for a time in these liquids. Thus he kept the parts from putrefying, and gave them besides such additional strength and firmness, as rendered the dissections much more easy than they would otherwise have been. Having then divided the body transversely with the scissars, and made what observations he could without farther dissection, he proceeded to extract the intestines carefully with very fine instruments, to wash away the fat in the like careful manner; and thus to put the parts into such a state as would best expose them to view; but these operations are best performed while the insects are in their nymph state.

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Sometimes the delicate viscera of the insects, after Microscope having been suffocated as abovementioned, were put into water; after which, having shaken them gently, he procured an opportunity of examining them, especially the air vessels, which last he could thus separate entire from all the other parts, to the admiration of all who beheld them; as these vessels cannot be distinctly seen in any other manner, or indeed in any way whatever, without injuring them. Frequently also he injected water with a syringe to cleanse the parts thoroughly, after which he blew them up with air and dried them; thus rendering them durable, and fit for examination at a proper opportunity. Sometimes he made very important discoveries, by examining insects which he had preserved for several years in balsam. Other insects he punctured with a very fine needle; and after squeezing out all their moisture through the holes made in this manner, he filled them with air, by means of very slender glass tubes; then dried them in the shade; and lastly anointed them with oil of spike in which a little rosin had been dissolved; and by which means they, for a long time, retained their proper forms. He was likewise in possession of a singular secret, by which he could preserve the limbs of insects as limber and perspicuous as ever they had been. He used to make a small puncture or incision in the tails of worms; and after having with great caution squeezed out all the humours, as well as great part of the viscera, he injected them with wax in such a manner as to give them the appearance of living creatures in perfect health. He found that the fat of all insects was entirely dissolvable in oil of turpentine; by which means he was enabled plainly to discern the viscera; though, after this dissolution, it was necessary to cleanse and wash them frequently in clean water. In this manner he would frequently have spent whole days in the preparation of a single caterpillar, and cleansing it from its fat, in order to discover the true situation of the insect's heart. He had a singular dexterity in stripping off the skins of caterpillars that were on the point of spinning their cones. This was done by letting them drop by their threads into scalding water, and then suddenly withdrawing them. Thus the epidermis peeled off very easily; and, when this was done, he put them into distilled vinegar and spirit of wine mixed together in equal proportions; which, by giving a due degree of firmness to the parts, gave him an opportunity of separating them with very little trouble from the exuviae, without any danger to the internal parts. Thus the nymph could be shown to be wrapped up in the caterpillar and the butterfly in the nymph; and there is little doubt that those who look into the works of Swammerdam, will be amply recompensed, whether they consider the unexampled labour or the piety of the author.

M. Lyonet, a late eminent naturalist, usually drowned the insects he designed to examine; by which means he was enabled to preserve both the softness and transparency of the parts. According to him, the insect, if very small, viz. one tenth of an inch, or little more, in length, should be dissected on a glass somewhat concave. If it should be suspected that the insect will putrefy by keeping for a few days, spirit of wine diluted with water must be substituted instead of pure water. The insect must be suffered to dry; after which it may

Microscope be fastened by a piece of soft wax, and again covered with water.—Larger objects should be placed in a trough of thin wood; and for this purpose the bottom of a common chip box will answer very well; only surrounding the edge of it with soft wax, to keep in the water or other fluid employed in preserving the insect. The body is then to be opened; and if the parts are soft like those of a caterpillar, they should be turned back, and fixed to the trough by small pins, which ought to be set by a small pair of nippers. At the same time, the skin being stretched by another pair of finer forceps, the insect must be put into water, and dissected therein, occasionally covering it with spirit of wine. Thus the subject will be preserved in perfection, so that its parts may be gradually unfolded, no other change being perceived than that the soft elastic parts become stiff and opaque, while some others lose their colour.

The following instruments were made use of by M. Lyonet in his dissection of the *Chenille de Saul*. A pair of scissars as small as could be made, with long and fine arms: A pair of forceps, with their ends so nicely adjusted, that they could easily lay hold of a spider's thread, or a grain of sand: Two fine steel needles fixed in wooden handles, about two inches and three quarters in length; which were the most generally useful instruments he employed.

Dr Hooke, who likewise made many microscopic observations, takes notice, that the common ant or pismire is much more troublesome to draw than other insects, as it is extremely difficult to get the body in a quiet natural posture. If its feet be fettered with wax or glue, while the animal remains alive, it so twists its body, that there is no possibility of gaining a proper view of it; and if it be killed before any observation is made, the shape is often spoiled before it can be examined. The bodies of many minute insects, when their life is destroyed, instantly shrivel up; and this is observable even in plants as well as insects, the surface of these small bodies being affected by the least change of air; which is particularly the case with the ant. If this creature, however, be dropped into rectified spirit of wine, it will instantly be killed; and when it is taken out, the spirit of wine evaporates, leaving the animal dry, and in its natural posture, or at least in such a state that it may easily be placed in whatever posture we please.

Parts of Insects. The wings, in many insects, are so transparent, that they require no previous preparation: but some of those that are folded up under *elytra* or cases, require a considerable share of dexterity to unfold them; for these wings are naturally endowed with such a spring, that they immediately fold themselves again, unless care be taken to prevent them. The wing of the earwig, when expanded, is of a tolerable size, yet is folded up under a case not one eighth part of its bulk; and the texture of this wing renders it difficult to be unfolded. This is done with the least trouble immediately after the insect is killed. Holding then the creature by the thorax, between the finger and thumb, with a blunt-pointed pin endeavour gently to open it, by spreading it over the fore-finger, and at the same time gradually sliding the thumb over it. When the wing is sufficiently expanded, separate it from the insect by a sharp

knife or a pair of scissars. The wing should be pressed for some time between the thumb and finger before it be removed; it should then be placed between two pieces of paper, and again pressed for at least an hour; after which time, as there will be no danger of its folding up any more, it may be put between the tales, and applied to the microscope. Similar care is requisite in displaying the wings of the notonecta and other water-insects, as well as most kinds of grylli.

The minute *scales* or *feathers*, which cover the wings of moths or butterflies, afford very beautiful objects for the microscope. Those from one part of the wing frequently differ in shape from such as are taken from other parts; and near the thorax, shoulder, and on the fringes of the wings, we generally meet with hair instead of scales. The whole may be brushed off the wing, upon a piece of paper, by means of a camel's-hair pencil; after which the hairs can be separated with the assistance of a common magnifying glass.

It is likewise a matter of considerable difficulty to dissect properly the *proboscis* of insects, such as the gnat, tabanus, &c. and the experiment must be repeated a great number of times before the structure and situation of the parts can be thoroughly investigated, as the observer will frequently discover in one what he could not in another. The *collector of the bee*, which forms a very curious object, ought to be first carefully washed in spirit of turpentine; by which means it will be freed from the unctuous matter adhering to it: when dry, it is again to be washed with a camel's-hair pencil to disengage and bring forward the small hairs which form part of this microscopic beauty. The best method of managing the *stings* of insects, which are in danger of being broken by reason of their hardness, is to soak the case and the rest of the apparatus for some time in spirit of wine or turpentine; then lay them on a piece of paper, and with a blunt knife draw out the sting, holding the sheath with the nail of the finger or any blunt instrument; but great care is necessary to preserve the *feelers*, which when cleaned add much to the beauty of the object. The *beard* of the *lepas antifer* is to be soaked in clean soft water, frequently brushing it while wet with a camel's-hair pencil: after it is dried, the brushing must be repeated with a dry pencil to disengage and separate the hairs, which are apt to adhere together.

To view to advantage the *fat*, *brains*, and other similar substances, Dr Hooke advises to render the surface smooth, by pressing it between two plates of thin glass, by which means the matter will be rendered much thinner and more transparent: without this precaution, it appears confused, by reason of the parts lying too thick upon one another. For *muscular fibres*, take a piece of the flesh, thin and dry; moisten it with warm water, and after this is evaporated the vessels will appear more plain and distinct; and by repeated macerations they appear still more so. The *exuviae* of insects afford a pleasing object, and require but little preparation. If bent or curled up, they will become so relaxed by being kept a few hours in a moist atmosphere, that you may easily extend them to their natural positions; or the steam of warm water will answer the purpose very well.

The *eyes* of insects in general form very curious and

Microscope and beautiful objects. Those of the libellula and other flies, as well as of the lobster, &c. must first be cleaned from the blood, &c. after which they should be soaked in water for some days: one or two skins are then to be separated from the eye, which would be otherwise too opaque and confused; but some care is requisite in this operation; for if the skin be rendered too thin, it is impossible to form a proper idea of the organization of the part. In some substances, however, the organization is such, that by altering the texture of the part, we destroy the objects which we wish to observe. Of this sort are the nerves, tendons, muscular fibres, many of which are viewed to most advantage when floating in some transparent fluid. Thus very few of the muscular fibres can be discovered when we attempt to view them in the open air, though great numbers may be seen if they be placed in water or oil. By viewing the thread of a ligament in this manner, we find it composed of a vast number of smooth round threads lying close together. Elastic objects should be pulled or stretched out while they are under the microscope, that the texture and nature of those parts, the figure of which is altered by being thus pulled out, may be more fully discovered.

Other objects. To examine bones by the microscope, they should first be viewed as opaque objects; but afterwards, by procuring thin slices of them, they may be viewed as transparent. The sections should be cut in all directions, and be well washed and cleaned; and in some cases maceration will be useful, or the bones may be heated red hot in a clear fire, and then taken out; by which means the bony cells will appear more conspicuous. The pores of the skin may be examined by cutting off a thin slice off the upper skin with a razor, and then a second from the same place; applying the latter to the microscope. The lizard, guana, &c. have two skins, one very transparent, the other thicker and more opaque; and, separating these two, you obtain very beautiful objects.

To view the scales of fish to advantage, they ought to be soaked in water for a few days, and then carefully rubbed to clean them from the skin and dirt which may adhere to them. The scales of the eel are a great curiosity; and the more so, as this creature was not known to have any scales till they were discovered by the microscope. The method of discovering them is this. Take a piece of the skin of an eel from off its side, and spread it while moist on a piece of glass, that it may dry very smooth: when thus dried, the surface will appear all over dimpled or pitted by the scales, which lie under a sort of cuticle or thin skin; which may be raised with the sharp point of a penknife, together with the scales, which will then easily slip out; and thus we may procure as many as we please.

The leaves of many trees, as well as of some plants, when dissected, form a very agreeable object. In order to dissect them, take a few of the most perfect leaves you can find, and place them in a pan with clean water. Let them remain there three weeks, or a month, without changing the water; then take them up; and if they feel very soft, and almost rotten, they are sufficiently soaked. They must then be laid on a flat board, and holding them by the stalk, draw the

edge of a knife over the upper side of the leaf, which will take off most of the skin. Then turn the leaf, and do the same with the under side; and when the skin is taken off on both sides, wash out the pulpy matter, and the fibres will be exhibited in a very beautiful manner. The leaf may be slit into two parts, by splitting the stalk; and the skins peeled from the fibres will also make a good object. This operation is best performed in the autumn: the fibres of the leaves are much stronger at that season, and less liable to be broken.—The internal structure of shells may be observed by grinding them down on a hone: and all ores and minerals should be carefully washed and brushed with a small brush to remove any fordes that may adhere to them.

To view the circulation of the blood, we must observe living animals of the most transparent kind.—A small eel is sometimes used for this purpose; in which case it must be cleansed from the slime naturally adhering to it; after which it may be put into a tube filled with water, where it can be viewed in a satisfactory manner. The tail of any other small fish may be viewed in the same manner, or put upon a slip of flat glass, and thus laid before the microscope. By filling the tube with water when an eel is made use of, we prevent in a great measure the sliminess of the animal from soiling the glass.

The particles of the blood form a very curious object, and have been carefully viewed by different philosophers; who, nevertheless, differ from one another very much in their accounts of them. The best method of viewing these is to take a small drop of blood when warm, and spread it as thin as possible upon a flat piece of glass. By diluting it a little with warm water, some of the large globules will be separated from the smaller, and many of them subdivided; or a small drop of blood may be put into a capillary glass-tube, and then placed before the microscope. Mr Baker advises warm milk as proper to be mixed with the blood; but Mr Hewson, who is accounted the most accurate observer, diluted the blood with that fluid which undoubtedly is more natural to it, viz. its own serum: by this method he could preserve the small particles entire, and view them distinctly; and thus he found that they were not globular, as had been imagined by other anatomists, but flat. Having shaken a piece of the crassamentum of the blood in serum till the latter became a little coloured, he spread it with a soft hair pencil on a piece of thin glass, which he placed under the microscope, in such a manner as not to be quite horizontal, but rather higher at one end than the other. Thus the serum flows from the higher to the lower part; and, as it flows, some of the particles will be found to swim on their flat sides, and will appear to have a dark spot in the middle; while others will turn over from one side to the other as they roll down the glass. Many cruel experiments have been tried in order to observe the circulation of the blood in living creatures, and an apparatus has been invented for viewing the circulation in the mesentery of a frog; but as this can answer no useful purpose, and will never be put in practice by persons of humanity, we forbear to mention it.

Microscope

II. Besides the objects for the microscope already mentioned, there are innumerable others, some hardly visible, and others totally invisible, to the naked eye; and which therefore, in a more peculiar sense, are denominated,

Microscopic animals. They are the animalcules or moving bodies in water, in which certain substances have been infused; and of which there are a great many different kinds. These animalcula are sometimes found in water which we would call *pure*, did not the microscopes discover its minute inhabitants; but not equally in all kinds of water, or even in all parts of the same kind of it. The surfaces of infusions are generally covered with a scum which is easily broken, but acquires thickness by standing. In this scum the greatest number of animalcules are usually found. Sometimes it is necessary to dilute the infusions; but this ought always to be done with water, not only distilled, but viewed through a microscope, lest it should also have animalcules in it, and thus prove a source of deception. It is, however, most proper to observe those minute objects after the water is a little evaporated; the attention being less diverted by a few objects than when they appear in great numbers. One or two of the animalcules may be separated from the rest by placing a small drop of water on the glass near that of the infusion; join them together by making a small connection between them with a pin; and as soon as you perceive that an animalcule has entered the clear drop, cut off the connection again.

Eels in paste are obtained by boiling a little flour and water into the consistence of book-binders paste; then exposing it to the air in an open vessel, and beating it frequently together to keep the surface from growing mouldy or hard. In a few days it will be found peopled with myriads of little animals visible to the naked eye, which are the eels in question. They may be preserved for a whole year by keeping the paste moistened with water; and while this is done, the motion of the animals will keep the surface from growing mouldy. Mr Baker directs a drop or two of vinegar to be put into the paste now and then. When they are applied to the microscope, the paste must be diluted in a piece of water for them to swim in.

Numberless animalcules are observed by the microscope in infusions of pepper. To make an infusion for this purpose, bruise as much common black pepper as will cover the bottom of an open jar, and lay it thereon about half an inch thick: pour as much soft water into the vessel as will rise about an inch above the pepper. Shake the whole well together: after which they must not be stirred, but be left exposed to the air for a few days; in which time a thin pellicle will be formed on the surface, in which innumerable animals are to be observed by the microscope.

The microscopic animals are so different from those of the larger kinds, that scarce any sort of analogy seems to exist between them; and one would almost be tempted to think that they lived in consequence of laws directly opposite to those which preserve ourselves and other visible animals in existence. They have been systematically arranged by O. F. Muller; though it is by no means probable that all the different classes

have yet been discovered. Such as have been observed, however, are by this author divided in the following manner.

I. *Such as have no external organs.*

1. Monas: Punctiforma. A mere point.
2. Proteus: Mutabilis. Mutable.
3. Volvox: Sphaericum. Spherical.
4. Enchelis: Cylindracea. Cylindrical.
5. Vibrio: Elongatum. Long.
* Membranaceous.
6. Cyclidium: Ovale. Oval.
7. Paramecium: Oblongum. Oblong.
8. Kolpoda: Sinuatum. Sinuous.
9. Gonium: Angulatum. With angles.
10. Bursaria. Hollow like a purse.

II. *Those that have external organs.*

* Naked, or not inclosed in a shell.

1. Cercaria: Caudatum. With a tail.
2. Trichoda: Crinitum. Hairy.
3. Kerona: Corniculatum. With horns.
4. Himantopus: Cirratum. Cirrated.
5. Leucophaea: Ciliatum undique. Every part ciliated.
6. Vorticella: Ciliatum apice. The apex ciliated.
* Covered with a shell.
7. Brachionus: Ciliatum apice. The apex ciliated.

I. *Monas.*

This is by our author defined to be "an invisible (to the naked eye), pellucid, simple, punctiform worm;" but of which, small as it is, there are several species.

1. The *monas termo* or *gelatinosa*, is a small jelly-like point, which can be but imperfectly seen by the single microscope, and not at all by the compound one. In a full light they totally disappear, by reason of their transparency. Some infusions are so full of them that scarce the least empty space can be perceived; the water itself appearing composed of innumerable globular points, in which a motion may be perceived somewhat similar to that which is observed when the sun's rays shine on the water; the whole multitude of animals appearing in commotion like a hive of bees. This animal is very common in ditch-water, and in almost all infusions either of animal or vegetable substances.

2. *Monas atomus* or *albida*; white monas with a variable point. This appears like a white point, which thro' a high magnifier appears somewhat egg-shaped. The smaller end is generally marked with a black point, the situation of which is variable; sometimes it appears on the large end, and sometimes there are two black spots in the middle. This species was found in sea-water, which had been kept through the whole winter, but was not very fetid. No other kind of animalcule was found in it.

3. *Monas punctum* or *nigra*, black monas. This was found in a fetid infusion of pears, and appears in form of a very minute, opaque, and black point, moving with a slow and wavering motion.

4. *Monas ocellus*, transparent like talc, with a point in the middle. This is found in ditches covered with con-

ferva,

Microscope ferva, and sometimes with the cyclidium milium; the margin of it is black, with a black point in the middle.

5. *Monas lens* or *hyalina*; of a talc appearance. This is found in all kinds of water; sometimes even in that which is pure, but always in the summer-time in ditch-water. It is found also in all infusions of animal or vegetable substances, whether in fresh or salt water; myriads being contained in a single drop. It is found likewise in the filth of the teeth. It is nearly of a round figure; and so transparent, that it is impossible to discover the least vestige of intestines. They generally appear in clusters, but sometimes singly. Contrary to what happens to other animalcules, they appear to cover the edges of the drop when evaporating, and where they instantly die. A few dark shades, probably occasioned by the wrinkling of the body, are perceived when the water is nearly evaporated. The motions of this animalcule are generally very quick; and two united together, may sometimes be seen swimming among the rest; which is thought to be a single one generating another by division, as is related under the article ANIMALCULE. These and the animalcules of the first species are so numerous, that they exceed all calculation even in a very small space.

6. *Monas mica*, marked with a circle. This is found in the purest waters, and may be discovered with the third lens of the single microscope when the magnifying power is increased. It appears like a small lucid point; but can assume an oval or spherical shape at pleasure: sometimes the appearance of two kidneys may be perceived in its body, and there is commonly the figure of an ellipse in it; the situation of which is moveable, sometimes appearing in the middle and sometimes approaching to either extremity. It seems encompassed with a beautiful halo, which is thought to be occasioned by the vibration of fine invisible hairs. It has a variety of motions, and often turns round for a long time in the same place.

7. The *tranquilla*, or egg-shaped transparent monas with a black margin, is found in urine which has been kept for some time. Urine in this state acquires a scum in which the animalcules reside; but though kept for several months, no other species was found in it. A drop of urine is usually fatal to other animalcules, though this species is to be met with in no other substance. It is generally fixed to one point, but has a kind of vacillatory motion. Frequently these creatures are surrounded with a halo. Sometimes they are quadrangular, and at other times spherical; the black margin is not always to be found; and sometimes there is even an appearance of a tail.

8. The *lamellula*, or flat transparent monas, is most usually found in salt-water; is of a whitish colour and transparent, more than twice as long as it is broad, with a dark margin, having a vacillatory motion, and frequently appearing as double.

9. The *pulvisculus* or *monas* with a green margin. These are generally found in marshy grounds in the month of March. They appear like small spherical grains of a green colour on the circumference, having sometimes a green bent line passing through the middle. They appear sometimes in clusters, from three to seven or more in number, having a wavering kind of motion.

10. The *uva*, or transparent gregarious mona, is found in a variety of infusions, and is of that kind which multiplies by dividing itself. They appear in clusters of four, five, or sometimes many more; the corpuscles being of various sizes, according to the number collected into one group. The smaller particles, when separated from the larger, move about with incredible swiftness. A single corpuscle separated from the heap, and put by itself into a glass, soon increased in size till it nearly attained the bulk of the parent group. The surface then assumed a wrinkled appearance, and gradually became like the former, separating again into small particles, which likewise increased in bulk as before.

II. The Proteus.

An invisible, very simple, pellucid worm, of a variable form.

1. The *diffuens*, branching itself out in a variety of directions. It is very rare, and only met with in fens; appearing like a grey mucous mass, filled with a number of black globules, and continually changing its figure, pushing out branches of different lengths and breadths. The internal globules divide immediately, and pass into the new formed parts; always following the various changes of the animalcule; which changes seem to proceed entirely from the internal mechanism of its body, without the aid of any external power.

2. The *tenax*, running out into a fine point. This is a pellucid gelatinous body, stored with black molecules, and likewise changing its figure, but in a more regular order than the former. It first extends itself in a straight line, the lower part terminating in a bright acute point. It appears to have no intestines; and when the globules are all collected in the upper part, it next draws the pointed end up toward the middle of the body, which assumes a round form. It goes through a number of different shapes, part of which are described under the article ANIMALCULE. It is found in some kinds of river-water, and appears confined almost entirely to one place, only bending sidewise.

III. Volvox.

An invisible, very simple, pellucid, spherical worm.

1. The *punctum*; of a black colour, with a lucid point. This is a small globule, with one hemisphere opaque and black, the other having a crystalline appearance; and a vehement motion is observed in the black part. It moves as on an axis, frequently passing thro' the drop in this manner. Many are often seen joined together in their passage through the water; sometimes moving as in a little whirlpool, and then separating. They are found in great numbers on the surface of fetid sea-water.

2. The *granulum* is of a spherical figure and green colour, the circumference being bright and transparent. It is found in marshy places about the month of June, and moves but slowly. It seems to have a green opaque nucleus.

3. The *globulus*, with the hinder part somewhat obscure, sometimes verges a little towards the oval in its shape, having a slow fluttering kind of motion, but more

Microscope more quick when disturbed. The intestines are but just visible. It is found in most vegetable infusions, and is ten times larger than the mona lens.

4. The *pilula*, small and round, with green intestines. This is found in water where the *lemna minor* grows, in the month of December, and has a kind of rotatory motion, sometimes slow and at others quick. The intestines are placed near the middle, apparently edged with yellow. There is a small incision on one of the edges of the sphere, which may possibly be the mouth of the creature. The whole animal appears encompassed with an halo.

5. The *grandinella*, with immoveable intestines, is much smaller than the last, and marked with several circular lines. The intestines are immoveable, and no motion is perceived among the interior molecules. Sometimes it moves about in a straight line, at others irregularly, and sometimes keeps in the same spot, with a tremulous motion.

6. The *socialis*, with crystalline molecules placed at equal distances from one another. This is found in water where the *chara vulgaris* has been kept; and has its molecules disposed in a sphere, filling up the whole body of the animalcule; but whether they be covered by a common membrane or united by a stalk (as in the *vorticella socialis* to be afterwards described) is not known. When very much magnified, some black points may be seen in the crystalline molecules. Its motion is sometimes rotatory and sometimes not.

7. The *sphericula*, with round molecules, appears to consist of pellucid homogeneous points of different sizes. It moves slowly from right to left and back again, about a quarter of a circle each time.

8. The *lunula*, with lunular molecules, is a small roundish transparent body, consisting of an innumerable multitude of homogeneous molecules of the shape of a crescent, without any common margin. It moves continually in a twofold manner, *viz.* of the molecules among one another, and the whole mass turning slowly round. It is found in marshy places in the beginning of spring.

9. The *globator*, or spherical membranaceous volvox, is found in great numbers in the infusions of hemp and tremella, and in stagnant waters in spring and summer; it was first observed and depicted by Leewenhoeck, but the descriptions of it given by authors differ considerably from each other. The following is that of Mr Baker. "There is no appearance of either head, tail, or fins. It moves in every direction, backwards, forwards, up or down, rolling over and over like a bowl, spinning horizontally like a top, or gliding along smoothly without turning itself at all; sometimes its motions are very slow, at other times very swift; and when it pleases it can turn round as upon an axis very nimble, without moving out of its place. The body is transparent, except where the circular spots are placed, which are probably its young. The surface of the body in some is as if all dotted over with little points, and in others as if granulated like shagreen. In general it appears as if set round with short moveable hairs." Another author informs us, that "they are at first very small, but grow so large that they can be discerned with the naked eye: they are of a yellowish green colour, globular figure, and in

substance membranaceous and transparent; and in the midst of this substance several small globes may be perceived. Each of these are smaller animalcula, which have also the diaphanous membrane, and contain within themselves still smaller generations, which may be distinguished by means of very powerful glasses. The larger globules may be seen to escape from the parent, and then increase in size."

This little animal appears like a transparent globule of a greenish colour, the foetus being composed of smaller greenish globules. In proportion to its age it becomes whiter and brighter, and moves slowly round its axis; but to the microscope its surface appears as if granulated, the roundest molecules fixed in the centre being largest in those that are young. The exterior molecules may be wiped off, leaving the membrane naked. When the young ones are of a proper size, the membrane opens, and they pass through the fissure; after which the mother melts away. Sometimes they change their spherical figure, and become flat in several places. They contain from 8 to between 30 and 40 globules within the membrane.

10. The *morum*, with spherical green globules in the centre. This is found amongst the *lemna* in the months of October and December, and has a slow rotatory motion. The globules seldom move, though a slow quivering motion may sometimes be perceived among them in the centre.

11. The *alva*, composed of green globules not inclosed in any membrane, is found in the month of August in water where the *lemna polyrrhiza* grows. —It consists of a congeries of greenish-coloured globules, apparently of an equal size, with a bright spot in the middle; the whole mass is sometimes of a spherical form, sometimes oval, without any common membrane: a kind of halo may be perceived round it, and the mass generally moves from right to left, but scarce any motion can be perceived among the globules themselves. These masses contain from four to fifty globules, of which a solitary one may sometimes be seen. Sometimes also two masses of globules have been perceived joined together.

12. The *vegetans*, terminating in a little bunch of globules. This is found in river-water in the month of November. It consists of a number of floccose opaque branches invisible to the naked eye; and at the apex of these is a small congeries of very minute oval pellucid corpuscles. Muller, who discovered this, supposed it at first to be a species of microscopic and river fertularia; but he afterwards found the bunches quitting the branches, and swimming about in the water with a proper spontaneous motion; many of the old branches being deserted, and the younger ones furnished with them.

IV. *Enchelis* :

A simple, invisible, cylindric worm.

1. The *viridis*, or green *enchelis*, has an obtuse tail, the forepart terminating in an acute truncated angle; the intestines are obscure and indistinct. It continually varies its motion, turning from right to left.

2. The *punctifera*, having the fore part obtuse, the hinder part pointed. It is opaque, and of a green colour, with a small pellucid spot in the fore part, in which two black points may be seen; and a kind of double

Microscope double band crosses the middle of the body. The hinder part is pellucid and pointed, with an incision, supposed to be the mouth, at the apex of the fore-part. It is found in marshes.

3. The *deses*, or gelatinous enchelis, is found, though rarely, in an infusion of lemnæ, and moves very slowly. The body is round, of a very dark-green, the fore-part bluntly rounded off, and the hinder part somewhat tapering, but finished with a round end: near the extremities there is a degree of transparency.

4. The *similis*, with moveable intestines, is found in water that has been kept for several months: it is of an egg-shape, and generally moves very quick, either to the right or left. It is supposed to be furnished with hairs, because when moving quickly the margin appears striated. The body is opaque with a pellucid margin, and filled with moveable spherules.

5. The *serotina*, with immoveable intestines, is of an oval figure, partly cylindrical, the fore-part smaller than the hind, with a black margin, full of gray vesicular molecules: it moves very slowly.

6. The *nebulosa*, with visible moveable intestines, is found in the same water with the cyclidium glaucoma, but is much more scarce. The body is egg-shaped, the fore-part narrow, and frequently filled with opaque confused intestines: when moving, it elevates the fore-part of the body. It is about three times as large as the cyclidium glaucoma.

7. The *feminulum* is found in water that has been kept for some days, and moves by ascending and descending alternately. It is of a cylindrical figure, twice as long as broad, the intestines in the fore-part transparent, but opaque in the hinder part. Sometimes it is observed swimming about with the extremities joined together.

8. The *intermedia*, with a blackish margin, is one of the smallest animalcules: it has a transparent body, without any visible intestines. The fore and hind parts are of an equal size, and the edge is of a deeper colour than the rest. Some have a point in the middle, others a line passing through it.

9. The *ovulum*, is transparent, round, and egg-shaped. A very strong magnifier discovers some long foldings on the surface, with a few bright molecules here and there.

10. The *pirum*, with the hinder part transparent, has the fore-part protuberant and filled with molecules. The hinder part is smaller and empty, with moveable molecular intestines. Its motion is rapid, passing backwards and forwards through the diameter of the drop. When at rest, it appears to have a little swelling on the middle of the body.

11. The *tremula* was found in an infusion with the paramæcia aurelia, and many other animalcules. It is among the least of these minute creatures, and is of a cylindrical figure and gelatinous texture. Its extremity appears pointed, and has a tremulous motion, so as to induce a suspicion that the creature has a tail. Two of these creatures may at times be seen to adhere together.

12. The *constricta*, with a stricture in the middle, is found in salt-water, and is of a very small size, having the middle drawn in as if tied with a string. It is of an oval shape.

13. The *elliptica*, with a congeries of green intestines,

Microscope is found among the green matter on the sides of vessels in which water has been kept for some time. It is of a roundish shape, and transparent; the fore-part obtuse, the hinder part rather sharp, and marked with green spots. They are generated in such numbers, that myriads may sometimes be found in one drop.

14. The *fusus*, with both ends truncated, was found in water called pure, and had a languid motion. The body is round and transparent, with the fore and hind parts somewhat smaller than the rest. In the inside is a long and somewhat winding intestine, with a bright sky-coloured fluid, and some black molecules transversely situated.

15. The *fritillus*, with the fore-part truncated, is found in an infusion of grass and hay, and runs backward and forward through the drop with a wavering motion. It is one of the most transparent animalcules, and has the fore-part obtusely convex.

16. The *caudata*, with a kind of tail, is but seldom met with. The body is grey and transparent, with globular molecules divided from each other, and dispersed thro' the whole; the fore-part is thick and obtuse, the hind part crystalline and small, the end truncated.

17. The *epistomium*, with the fore-part slender and roundish, is among the smaller animalcula; the body cylindrical and bright, the hind part obtuse, the fore-part smaller, and terminating in a globule, with now and then a black line down the middle.

18. The *gemmata* is found in ditch-water where the lemna thrives. It has a cylindrical body, the upper part running out into a transparent neck, with a double series of globules running down the body. It moves slowly, and generally in a straight line.

19. The *retrograda* moves commonly sideways, and sometimes in a retrograde manner. It has a gelatinous transparent body, thicker in the middle than at the ends, without any thing that can be called intestines, except a pellucid globule discoverable near the hinder part.

20. The *festinans*, with obtuse ends, is found in sea-water, and has a quick vacillatory motion from one side to the other. The body is round, with the fore-part transparent. More than half the length of it is without any visible intestines; but the lower end is filled with minute vesicular and transparent globules; a large globular vesicle is also observed in the fore-part.

21. The *farcimen* was found by Joblot in an infusion of blue bottles, moving very slowly in an undulatory manner. The body is cylindrical, about four times as long as broad, truncated at both ends, the intestines opaque, and not to be distinguished from one another. It forms itself into the shape of the letter S, by turning the two extremities contrariwise.

22. The *index* is found in water with the lemna minor; the body opaque, of a grey colour, and long conical shape: the lower end is obtuse, one side projecting like a finger from the edge, with two very small projections from the lower end. It has the power of retracting these projections, and making both ends appear obtuse.

23. The *truncus*, with a kind of head, is the largest of this kind of animalcules. The body is grey, long, and mucous; the fore-part globular, the hinder part obtuse; but it can alter its shape considerably. Sometimes there is an appearance of three teeth proceeding from

Microscope from one of the sides. Globules of different sizes may be observed within the body. The creature rolls slowly about from right to left.

24. The *larva* is long, round, and filled with molecules. The fore-part is obtuse and transparent, with a kind of neck or small contraction formed near this end: the lower part is pointed; and about the middle of the body are two small pointed projections like nipples, one on each side.

25. The *spatula*, with the fore-part transparent, and of the shape of a spatula. It is perfectly cylindrical, crystalline, and marked with fine longitudinal furrows; having generally two transparent globules, one below the middle, the other near the extremity. It moves in a wavering kind of manner, retaining its general form, but moving the spatula in various ways. Muller informs us, that he saw it once draw the spatula within the body, and keep it there for two hours.

26. The *pupula*, with the fore-part papillary, is found in dunghill water in November and December: it has a rotatory motion on a longitudinal axis, and moves in an oblique direction through the water. Both ends are obtuse; and the hinder part is marked with a transparent circle, or circular aperture.

27. The *pupa*, with a small nipple proceeding from the apex, has a very slow motion, and resembles the former, only that it wants the transparent circle, and is much larger. It is all opaque but the fore-end, and filled with obscure points.

V. *Vibrio*:

A very simple, invisible, round, and rather long worm.

1. The *lineola* is found in most vegetable infusions in such numbers, that it seems to fill up almost the whole of their substance. It is so small, that with the best magnifiers we can discern little more than an obscure tremulous motion among them. It is more slender than the *monas terma*.

2. The *rugula* is like a bent line; and sometimes draws itself up in an undulated shape, at others moves without bending the body at all.

3. The *bacillus*, equally truncated at both ends, is found in an infusion of hay; but Muller mentions the following remarkable fact, *viz.* that having made two infusions of hay in the same water, he put the hay whole in the one, but cut it in pieces in the other: he found in the former none of the *vibrio bacillus*, but many of the *monas lens* and *kolpoda cucullus*; in the latter were many of the *vibrio*, but few of the other.—This is from six to ten times longer than the *monas lens*, but much more slender.

4. The *undula*, is a round, gelatinous, little, undulating line. This is the animal which Leewenhoeck says is less than the tail of one of the seminal animalcules. It never appears straight; but when at rest it resembles the letter V, and when in motion the letter M. It commonly rests on the top of the water: sometimes it fixes itself by one extremity, and whirls round.

5. The *serpens*, with obtuse windings or flexures, is found in river-water, but seldom. It is slender, and gelatinous, resembling a serpentine line, with an intestine down the middle.

6. The *spirillum* is exceedingly minute, and twisted in the form of a spiral, which seems to be its natural N° 219.

shape, as it never untwists itself, but moves forward in a straight line, vibrating the hind and fore parts. It was found in 1782 in an infusion of the *sonchus arvensis*.

7. The *vermiculus* has a milky appearance, with an obtuse apex, and a languid undulatory motion, like that of the common worm. It is found in marshy water in November, but seldom. It is thought to be the animal mentioned by Leewenhoeck as found in the dung of the frog and spawn of the male libellula.

8. The *intestinum* is found in marshy waters, and has a slow progressive motion. It is milk-coloured, with two obtuse ends, and four or five spherical eggs are perceivable at the hinder extremity.

9. The *bipunctatus* is found in fetid salt-water, and moves slowly; for the most part in a straight line. The body is pellucid, and of a talc-like appearance; both ends are truncated, and in the middle one or two pellucid globules placed lengthwise.

10. The *tripunctatus* is also transparent and talcy, with both ends tapering. It has three pellucid globules, the middle one of which is largest, the space between them being generally filled with a green matter. It moves in a straight line, backwards and forwards.

11. The *paxilifer*, or straw-like vibrio, consists of a transparent membrane, with yellow intestines, and two or three visible points. They are found in parcels together from seven to forty in number, and ranged in a variety of forms. When at rest, they generally assume a quadrangular figure; and are thought to have some affinity to the *hair-like animal* described by Mr Baker, and of which an account is given under the article ANIMALCULE, N° 3.

12. The *lunula*, or bow-shaped vibrio, resembles the moon at its first quarter; it is of a green colour, and has from seven to ten globules disposed in a longitudinal direction.

13. The *verminus* is found in great plenty in salt-water kept for some days till it becomes fetid. It moves quickly, and with an undulatory motion, backwards and forwards. It is a long transparent membrane, with the hind part broader than the fore one. These animalcula seem to be joined together in a very singular manner.

14. The *malleus* is found in great plenty in spring-water, and is alternately at rest and in motion every moment; in the former case resembling the letter T, and in the latter V. It is a white pellucid animalcule, with a globule affixed to the base.

15. The *acus* is in the shape of a sewing needle; the neck round and partly transparent, and marked in the middle with a red point; the tail resembling a fine bristle.

16. The *sagitta*, with a setaceous tail, has a long and flexible body; broadest about the middle, and filled there also with grey molecules; the fore-part being drawn out into a thin and transparent neck, and the upper end thick and black. It is found in salt-water, and seems to move by contracting and extending its neck.

17. The *gordius*, with a tail terminated by a small tubercle, was found in an infusion made with salt water. Its fore part throughout about one sixth of its length is transparent, and furnished with an alimentary tube of a sky colour; the lower part being

Microscope ing bright and pointed, and the middle full of small globules.

18. The *serpentulus*, somewhat pointed at both ends. This is found in the infusions of vegetables which have been kept for some weeks. Its body is of a whitish colour, frequently convoluted, and drawn into different figures. The tail is furnished with a long row of very minute points.

19. The *coluber* is found in river-water; the tail is extremely small, and bent so as to form a considerable angle with the body; the mouth, œsophagus, the molecules in the intestines, and the twistings of them, are easily discerned.

20. The *anguillula* is divided into four varieties: 1. The vinegar cel; 2. That in paste; 3. That of fresh water; and, 4. That of salt. The two first are treated of under the article ANIMALCULE; the third is exceedingly transparent, with a few transverse lines upon the body, but without any appearance of intestines. Sometimes it has a long row of little globules, and is frequently furnished with two small oval ones; the tail terminates in a point. It has been found in the sediment formed by vegetables on the sides of vessels in which water had been kept for a long time. The fourth variety appears, when pressed between two glass plates, to be little more than two crystalline skins with a kind of intestines of a clay colour. The younger ones are furnished with pellucid molecules.

21. The *linter*, or ventricose oval vibrio, with a short neck, is found among the *lemnæ*, but not very frequently. It is among the larger kinds of animalcules, egg-shaped, pellucid, inflated, and somewhat depressed at top; having a moveable crystalline neck, and the belly filled with pellucid molecules.

22. The *utriculus* resembles a bottle; the belly is full of molecular intestines; the neck bright and clear, the top truncated, and some have a pellucid point at the bottom of the belly. It has a constant and violent vacillatory motion, the neck moving very quickly from side to side.

23. The *fasciola* is found in water just freed from the frost, and not often in any other fluid. It is pellucid, with intestines like points in the middle. There is likewise an alimentary canal gradually diminishing in size. Its motion is very quick.

24. The *colymbus* is larger than many of the other species of vibrio, and resembles a bird in shape. The neck, which is a little bent, is round, shorter than the trunk, of an equal size throughout, and of a bright appearance, with the apex obtuse. The trunk is thick, somewhat triangular, full of yellow molecules; the fore-part broad, the hinder part acute, the motion slow.

25. The *stridus* has a linear body, being a bright membranaceous thread; the hinder part somewhat thicker, round, and filled with molecules, excepting at the end, where there is a small empty pellucid space. It can draw in the slender filiform part at pleasure.

26. The *anas*, with both ends attenuated, and the neck longer than the tail, is found in salt water; tho' a kind is likewise found in fresh water with a neck longer than the other. The trunk of this animalcule is oblong, opaque, and filled with molecules; the fore and hind parts are drawn out into a pellucid talc membrane, which the creature can retract at pleasure.

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Microscope 27. The *cygnus* is a very pellucid line, crooked at top, swelling in the middle, and sharp at the end; the middle full of dark coloured molecules and pellucid intestines. It is very small, and moves more slowly than any of those that move and advance their necks.

28. The *anser* is found in water where duckweed grows. The trunk is elliptic, round, and without any inequality on the sides. It is full of molecules: the hind part sharp and bright; the fore part produced into a bending neck, longer than the body; the apex whole and even, with blue canals passing between the marginal edges, occupying the whole length of the neck; and in one of them a violent descent of water to the beginning of the trunk is observable. It moves the body slow, but the neck more briskly.

29. The *olor* is found in water that has been kept for a long time, and is full of vegetable green matter. The body is elliptical and ventricose, the hind part somewhat sharp, and sometimes filled with darkish molecules. The neck is three or four times longer than the body; of an equal size throughout, and is moved very quickly; but the motion of the body itself is slow.

30. The *falk*, with a crooked neck, and obtuse hinder part, is pellucid and elliptical; the fore part lessening into a little, round, bright neck, nearly as long as the trunk. The latter is somewhat gibbous, and filled with very small molecules; and there are two small bright globules, one within the hind extremity, and the other in the middle of the body. The neck of this animalcule is immovable; whence it moves something like a scythe.

31. The *intermedius* appears to be an intermediate species betwixt the *falk* and the *fasciola*. It seems to be a thin membrane constantly folded. The whole has a crystalline talc appearance; the middle filled with grey particles of different sizes. It has all round a distinct bright margin.

VI. *Cyclidium*.

A simple, invifible, flat, pellucid, orbicular or oval worm.

1. The *bulla*, or orbicular bright cyclidium. This is found occasionally in an infusion of hay. It is very pellucid and white, but the edges somewhat darker than the rest. It moves slowly, and in a semicircular direction.

2. The *millium* is very pellucid, and splendid like crystal; and of an elliptical figure, with a line through the whole length of it. The motion is swift, interrupted, and fluttering.

3. The *fluitans* is one of the smallest animalcula; the body somewhat of an oval shape, with two small blue spaces at the sides.

4. The *glaucoma* has an oval pellucid body, with both ends plain, or an oval membrane with a distinct well-defined edge. The intestines are so transparent, that they can scarce be discerned when it is empty. When full, they are of a green colour, and there are dark globules discoverable in the middle. When there is plenty of water this animalcule moves swiftly in a circular and diagonal direction; when it moves slowly, it seems to be taking in water, and the intestines are in a violent commotion. It generates by division.

5. The *nigricans* is very small, pellucid, and flat, with a black margin

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6. The *rostratum* is oval, smooth, and very pellucid, with the fore part running out into an obtuse point, with which it seems to feel and examine the bodies to which it comes. The intestines are filled with a blue liquor, the colour of which sometimes vanishes, and then they seem to be composed of vesicles.

7. The *nucleus* resembles a grape seed, the body being pellucid and depressed, the fore part obtusely convex, and the hind part acute.

8. The *hyalinum* has a tremulous kind of motion; the body oval, flat, and bright, without any visible intestines.

9. The *pediculus* is scarce ever seen but on the *hydra pallida*, upon which it runs as if it had feet. It is gelatinous and white; the bottom gibbous over the back; the extremities depressed and truncated, with one end sometimes apparently cloven into two, which may be supposed the mouth.

10. The *dubium* is of an oval shape, with one side convex, the other concave; the margin pellucid, and the inner part containing a great number of molecules.

VII. *Paramacium*.

An invisible, membranaceous, flat, and pellucid worm.

1. The *aurelia* is membranaceous, pellucid, and four times longer than it is broad; the fore part obtuse and transparent; the hind part filled with molecules. It has somewhat the appearance of a gimlet by reason of a fold which goes from the middle to the apex, and is of a triangular figure. It moves in a rectilinear and vacillatory manner. It is found in ditches where there is plenty of duckweed, and will live many months in the same water without any renewal of the latter.

2. The *chrysalis* is found in salt water, and differs very little from the former, only the ends are more obtuse, and the margins are filled with black globules.

3. The *versutum* is found in ditches, and has an oblong, green, and gelatinous body, filled with molecules; the lower part thicker than the other; and both ends obtuse. It propagates by division.

4. The *oviferum* is membranaceous, oval, grey, and pellucid, with many oval corpuscles dispersed through the body.

5. The *marginatum* is flat, elliptical, and every where filled with molecules, except in the lower end where there is a pellucid vesicle. It is surrounded by a broad double margin, and a bright spiral intestine is observable.

VIII. *Kolpoda*.

An invisible, pellucid, flat, and crooked worm.

1. The *lamella* is very seldom met with. It resembles a long, narrow, and pellucid membrane, with the hind part obtuse, narrower, and curved towards the top. It has a vacillatory and very singular motion; going upon the sharp edge, not on the flat side as is usual with microscopic animals.

2. The *gallinula* is found in fetid salt water; and has the apex somewhat bent, the belly oval, convex, and striated.

3. The *rostrum* is found though seldom, in water

where the *lemna* grows; and has a slow and horizontal motion. The fore part is bent into a kind of hook; the hind part obtuse, and quite filled with black molecules.

4. The *ochrea* is depressed, membranaceous, and flexible; one edge nearly straight; the other somewhat bent, filled with obscure molecules, and a few little bladders dispersed here and there.

5. The *mucronata* is a dilated bright membrane; the apex an obtuse point, with a broad marked border running quite round it. It is filled with grey molecules within the margin, and has a truncated appearance.

6. The *triquetra* was found in salt water, and appears to consist of two membranes; the upper side flattened, the lower convex, with the apex bent into a kind of shoulder.

7. The *striata* is likewise found in salt water, and is very pellucid and white, with the upper part rather bent, and terminating in a point; the lower part obtusely round: there is a little black pellucid vesicle at the apex; and with a very great magnifying power the body appears covered with long streaks.

8. The *nucleus* is of an oval shape, with the vertex pointed, and of a brilliant transparency, by which the viscera are rendered visible. These consist of a number of round diaphanous vesicles.

9. The *meleagris* has a dilated membrane, with very fine folds, which it varies in a moment. The fore part of the body to the middle is clear and bright; the hind part variously folded in transverse and elevated plaits and full of molecules. Beneath the apex are three or four teeth; but in some the edge is obtusely notched, and set with smaller notches. In the hinder part are 12 or more equal pellucid globules.

10. The *assimilis* is found on the sea-coast, and has an elliptic mass in the middle, but is not folded like the former. The margin of the fore part is notched from the top to the middle; the lower part swells out, and contracts again into a small point.

11. The *cucullus* is found in vegetable infusions, and in fetid hay; moving in all directions, and commonly with great vivacity. It is very pellucid, and has a well defined margin, filled with little bright vesicles differing in size, and of no certain number. Its figure is commonly oval, with the top bent into a kind of beak, sometimes oblong, but most commonly obtuse. It has in the inside from 8 to 24 bright little vesicles not discernible in such as are young. Some have supposed these to be animalcules which this creature has swallowed; but Mr Muller is of opinion that they are its offspring. When this creature is near death by reason of the evaporation of the water, it protrudes its offspring with violence. From some circumstances it would seem probable that this animalcule casts its skin, as is the case with some insects.

12. The *cucullulus* is found in an infusion of the *fonchus arvensis*. It is very pellucid and crystalline, with several globules, and has an oblique incision a little below the apex.

13. The *cuculio* is elliptical, flat on the upper side, and convex on the under; the fore part is clear, and from the middle to the hinder part is full of silver-like globules. It frequently stretches out the fore part, and folds it in different positions.

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14. The *ren*, or *crassa*, is found in an infusion of hay, commonly about 13 hours after the infusion is made, and has a quick and vacillatory motion. Its body is yellow, thick, and somewhat opaque; curved a little in the middle, so that it resembles a kidney; and full of molecules. When the water in which it swims is about to fail, it takes an oval form, is compressed, and at last bursts.

15. The *pirum* has an uniform and transparent body, without any sensible inequality; and is of a pale colour, with obscure little globules. It propagates by division.

16. The *suneus* is white, gelatinous, and without any distinct viscera; having a bright striated pellucid pustule on one side of the fore part. The apex has three or four teeth; and it can bend the hinder part into a spiral form.

IX. *Gonium*.

An invisible, simple, smooth, and angular worm.

1. The *peborale* is found in pure water, and moves alternately towards the right and left. It is quadrangular and pellucid, with 16 spherical molecules of a greenish colour, "set in a quadrangular membrane, like the jewels in the breast-plate of the high-priest, reflecting light on both sides."

2. The *pulvinatum* is found in dunghills; and appears like a little quadrangular membrane, plain on both sides: but with a large magnifier it appears like a bolster formed of three or four cylindric pillows sunk here and there.

3. The *corrugatum* is found in various kinds of infusions; and is somewhat of a square shape, very small, and in some positions appears as streaked.

4. The *reangulum* differs but little from the former: the angle at the base is a right one; the larger vesicle is transparent, the rest green.

5. The *truncatum* is found chiefly in pure water, and then but seldom. It has a languid motion, and is much larger than the foregoing. The fore part is a straight line, with which the sides form obtuse angles, the ends of the sides being united by a curved line. The internal molecules are of a dark green, and there are two little bright vesicles in the middle.

X. *Bursaria*.

A very simple, hollow, membranaceous worm.

1. The *truncatella* is visible to the naked eye; white, oval, and truncated at the top, where there is a large aperture descending towards the base. Most of them have four or five yellow eggs at the bottom. They move from left to right, and from right to left; ascending to the surface in a straight line, and sometimes rolling about while they descend.

2. The *bullina* is pellucid and crystalline, having splendid globules of different sizes swimming about with it. The under side is convex, the upper hollow, with the fore part forming a kind of lip.

3. The *hirundinella* has two small projecting wings, which give it somewhat of the appearance of a bird; and it moves something like a swallow. It is invisible to the naked eye; but by the microscope appears a pellucid hollow membrane.

4. The *duplella* was found among duckweed, and appears like a crystalline membrane folded up, with-

out any visible intestines except a small congenic of Microscope points under one of the folds.

5. The *globina* has a roundish shape, and is hollow; the lower end being furnished with black molecules of different sizes, the fore part with obscure points, the rest entirely empty, and the middle quite transparent. It moves very slowly from right to left.

XI. *Cercaria*.

An invisible transparent worm with a tail.

1. The *gyrinus* greatly resembles the spermatic animalcules. It has a white gelatinous body; the fore part somewhat globular; the hind part round, long, and pointed. Sometimes it appears a little compressed on each side. When swimming it keeps its tail in continual vibration like a tadpole.

2. The *gibba* is found in the infusions of hay and other vegetables; and is small, opaque, gelatinous, white, and without any visible intestines.

3. The *inquieta* is found in salt water, and is remarkable for changing the shape of its body: sometimes it appears spherical, sometimes like a long cylinder, and sometimes oval. It is white and gelatinous, the tail filiform and flexible, the upper part vibrating violently. A pellucid globule may be observed at the base, and two very small black points near the top.

4. The *lemnna* varies its form so much, that it might be mistaken for the proteus of Baker, described under the article ANIMALCULE; though in fact it is totally different. The body sometimes appears of an oblong, sometimes of a triangular, and sometimes of a kidney shape. The tail is generally short, thick, and annulated; but sometimes long, flexible, cylindric, and without rings; vibrating, when stretched out, with so much velocity, that it appears double. A small pellucid globule, which Muller supposes to be its mouth, is observable at the apex; and two black points not easily discovered, he thinks, are its eyes. Sometimes it draws the tail entirely into the body. It walks slowly after taking three or four steps, and extends the tail, erecting it perpendicularly, shaking and bending it; in which state it very much resembles a leaf of the lemna.

5. The *turbo*, with a tail like a bristle, is found among duckweed. It is of a tawny appearance, partly oval and partly spherical; and seems to be composed of two globular bodies, the lowermost of which is the smallest, and it has two little black points like eyes on the upper part. The tail is sometimes straight, sometimes turned back on the body.

6. The *poduria* is found in November and December, in marshy places covered with lemna. It is pellucid; and seems to consist of a head, trunk, and tail: the head resembles that of a herring; the trunk is ventricose and full of intestines, of a spiral form and black colour. The tail most commonly appears to be divided into two bristles. The intestines are in a continual motion when the body moves, and by reason of their various shades make it appear very rough. There are likewise some hairs to be perceived. It turns round as upon an axis when it moves.

7. The *viridis* is found in the spring in ditches of standing water; and in some of its states has a considerable resemblance to the last, but has a much greater power of changing its shape. It is naturally cylindrical,

Microscope cylindrical, the lower end sharp, and divided into two parts; but sometimes contracts the head and tail so as to assume a spherical figure.

8. The *setifera* is found in salt water, but seldom. It is small, the body rather opaque, and of a round figure. The upper part is bright, and smaller than the rest: the trunk is more opaque; the tail sharp, and near it a little row of short hairs. It has a slow rotatory motion.

9. The *hirta* was likewise found in salt water. It is opaque and cylindrical; and when in motion, the body appears to be surrounded with rows of small hairs separated from each other.

10. The *crumena* has a ventricose, cylindrical, thick, and wrinkled body; the lower part small; the upper part terminating in a small strait neck like that of a pitcher; the tail linear, and terminating in two diverging points.

11. The *catellus* has a moveable head fixed to the body by a point. The abdomen is twice as long as the head, full of intestines, and has a tail still narrower, and terminating in two bristles which it can unite and separate at pleasure. It moves briskly, but without going far from its first place.

12. The *catelina* was found in a ditch where there was plenty of duckweed. It is larger than the preceding, and has a thicker and more cylindrical body; the lower part truncated, with two short diverging points projecting from the middle.

13. The *lupus* is found in water among duckweed, and is larger than most of the genus. The head is larger than the body; the apex turned down into a little hook; the tail is like the body, but narrower, terminating in two very bright spines, which it extends in different directions. Sometimes it contracts into one half its common size, and again extends itself as before.

14. The *vermicularis* is long, cylindrical, fleshy, and capable of changing its shape. It is divided into eight or nine rings or folding plaits; the apex either obtuse, or notched into two points; the hinder part rather acute, and terminating in two pellucid thorns, between which a swelling is sometimes perceived. It often projects a kind of cloven proboscis from the incision at the apex. It is found in water where there is duckweed.

15. The *forcipata* is found in marshy places, is cylindrical and wrinkled, with a forked proboscis which it can thrust out or pull in.

16. The *pleuronectes* is found in water which has been kept for several months. It is membranaceous, roundish, and white, with two blackish points in the fore part, the hinder part being furnished with a slender sharp tail. It has orbicular intestines of different sizes in the middle; the larger of them bright. The motion is vacillatory; and in swimming it keeps one edge of the lateral membrane upwards, the other folded down.

17. The *tripos* is flat, pellucid, triangular, having each angle of the base or fore part bent down into two linear arms, the apex of the triangle prolonged into tail. It is found in salt water.

18. The *cyclidium* is frequently found in pure water, and has an oval, smooth, membranaceous, pellu-

Microscope cid body with a black margin. The tail is concealed under the edge, and comes out from it at every motion, but in such a manner as to project but little from the edge. There is also a kind of border to the hinder part.

19. The *tenax* appears like an oval pellucid membrane, something larger than the *monas lens*. The fore edge is thick and truncated; the hinder part acute, and terminating in a short tail. It whirls about in various directions with great velocity.

20. The *discus* is a small orbicular animalcule, with a bent tail.

21. The *orbis* is round, and has a tail consisting of two long bristles.

22. The *luna* is likewise round, and has the forepart hollowed into the form of a crescent.

XII. *Leucophra*.

An invisible, pellucid, and ciliated worm.

1. The *conflictor*, with moveable intestines, is perfectly spherical and semitransparent, of a yellow colour, the edges dark. It rolls from right to left, but seldom removes from the spot where it is first found. It is filled with a number of the most minute molecules, which move as if they were in a violent conflict; and in proportion to the number of these little combatants which are accumulated either on one side or other, the whole mass rolls either to the right or left. It then remains for a little time at rest, and the conflict ceases; but it soon becomes more violent, and the sphere moves the contrary way in a spiral line. When the water begins to fail, they assume an oblong, oval, or cylindric figure; the hinder part of some being compressed into a triangular shape, and the transparent part escaping as it were from the intestines, which continue to move with the same violence till the water fails, when the molecules shoot into a shapeless mass, which also soon vanishes, and the whole assumes the appearance of crystals of sal ammoniac.

2. The *mamilla* is of a dark colour, and filled with globular molecules; short hairs are curved inwards; and it occasionally projects and draws in a little white protuberance. It is pretty common in marshy water.

3. The *virescens* is a large, pear-shaped, greenish-coloured animalcule, filled with opaque molecules, and covered with short hairs; generally moving in a straight line. It is found in salt water.

4. The *viridis* is much smaller than the former, and cannot lengthen or shorten itself as it does. Sometimes it appears contracted in the middle, as if it were to be divided in two.

5. The *bursata* is found in salt water, and is similar in many respects to the former. It is of a long oval shape, bulging in the middle, and filled with green molecules, every where ciliated except at the apex, which is truncated and shaped somewhat like a purse; the hairs are sometimes collected into little fascicles.

6. The *posthuma* is globular, and covered as it were with a pellucid net; is found in fetid salt water.

7. The *aurea* is yellow, oval; has both ends equally obtuse; little hairs discovered with difficulty; and has in general a vehement rotatory motion.

8. The *pertusa* is found in salt water; and is gelatinous

Microscope tinous and small, without any molecules. The fore-part is truncated, the hind-part brought nearly to a point, with a kind of oval hole on one side.

9. The *fracta* is long, with sinuated angles, white, gelatinous, and granulated, changing its form considerably.

10. The *dilatata* appears like a gelatinous membrane, with a few grey molecules in the fore-part, and a great number in the hinder part. It is sometimes dilated into a triangular form with sinuated sides; at other times the shape is more irregular and oblong.

11. The *scintillans* was found in December among the lesser lemnæ. It is of a green colour, oval, round, and opaque. It is supposed to be ciliated from its bright twinkling appearance, which probably arises from the motion it gives the water.

12. The *vesiculifera* is oval, very pellucid, with a defined dark edge and inside, containing some very bright bladders or vesicles. The middle frequently appears blue, and the vesicles appear as if set in a ground of that colour.

13. The *globulifera* was found in a ditch where the *lemna minor* grew. The body is round, very pellucid, without molecules, but with three little pellucid globules, and every where set with short hairs.

14. The *pustulata* is found in marshy waters; and is white, gelatinous, and somewhat granulated; the lower part truncated as if an oblique section were made in an egg near the bottom. It is covered with little erect shining hairs, and at the lower extremity a few bright pustules may be discovered.

15. The *turbinata* is found in stinking salt water; and is round, pellucid, somewhat of the shape of an acorn, with a pellucid globule at the lower end.

16. The *acuta* is found in salt water, and is gelatinous, thick, capable of assuming different shapes; having the apex bright, and the rest of the body filled with little spherules. Sometimes it draws itself up into an orbicular shape, at others one edge is sinuated.

17. The *notata* is oval, round, and has a black point at the edge.

18. The *candida* is found in salt water; and is membranaceous, flat, very white, with no visible intestines except two oval bodies not easily perceived. The whole edge is ciliated.

19. The *nodulata* is oblong and oval, with a double row of little nodules.

20. The *signata* is common in salt water in the months of November and December. It is oblong and subdepressed, with a black margin filled with little molecules, but more particularly distinguished by a curved line in the middle somewhat in the shape of the letter S; one end of which is sometimes bent into the form of a small spiral.

21. The *trigona* is found in marshes, but not commonly. It is a yellow triangular mass filled with unequal pellucid vesicles, one of which is much larger than the rest, and the edge surrounded with short fluctuating hairs.

22. The *fluida* is somewhat of a kidney shape, but ventricose.

23. The *fluxa* is reniform and sinuated.

24. The *armilla* is round and annular.

25. The *cornuta* is of the shape of an inverted cone, opaque, and of a green colour. This requires to be

observed for some time before we can ascertain its characters. The body is composed of molecular vesicles; the fore part is wide and truncated, with a little prominent horn or hook on both sides; the hind part being conical, every where ciliated, and the hairs exceedingly minute; those in the fore part are three times longer than the former, and move in a circular direction. The hinder part is pellucid, and sometimes terminates in two or three obtuse pellucid projections. At one time this animalcule will appear reniform and ciliated on the fore part; but at another time the hairs are concealed. It dissolves into molecular vesicles when the water evaporates.

26. The *heteroclita* appears to the naked eye like a white point; in the microscope as a cylindrical body, the fore part obtusely round, the middle rather drawn in; the lower part round, but much smaller than the upper part. It appears wholly ciliated through a large magnifier.

XIII. *Trichoda*.

An invisible, pellucid, hairy worm.

1. The *grandinella* is a very small pellucid globule, with the intestines scarce visible, the top of the surface furnished with several small bristles not easily discoverable, as the creature has a power of extending or drawing them back in an instant. It is found in pure water as well as in infusions of vegetables.

2. The *cometa* is a pellucid globule filled with bright intestines, the fore part furnished with hairs, the hind part with a pellucid globule.

3. The *granata* resembles the two former; and has a darkish nucleus in the centre, with short hairs on the edge.

4. The *trochus* is somewhat of a pear-shape, and pellucid; each side of the fore part being distinguished by a little bunch of hairs.

5. The *gyrinus* is one of the smallest of this genus, and is found in salt water. It is smooth and free from hairs, except at the fore part, where there are a few.

6. The *sol* is small, globular, and crystalline; beset every where with diverging rays longer than the diameter of the body; the inside full of molecules. The body contracts and dilates, but the creature remains confined to the same spot. It was found with other animalcules in water which had been kept three weeks.

7. The *solaris* is orbicular, bright, and filled with globular intestines, frequently having in it a moveable substance of the shape of the letter S. It has hairs seldom exceeding 17 in number, set round the circumference, each of them nearly equal in length to the diameter of the animalcule.

8. The *bomba* is of a yellow colour, and full of clay-like molecules. It moves with such velocity as to elude the sight, and appears of various shapes, sometimes spherical, sometimes kidney-shaped, &c.

9. The *orbis* is composed of vesicular molecules; is of a spherical figure, smooth, pellucid, and a little notched in the fore part. The notched part is filled with long hairs, but there are none on the rest of the body.

10. The *urnula* is membranaceous, pellucid, somewhat in the form of a water pitcher, with the fore part hairy. It moves but slowly.

11. The *diota* is of a clay-colour, and filled with molecules;

Microscope molecules; the upper part cylindrical and truncated, the lower part spherical, the upper part of the mouth hairy at the edges.

12. The *horrida* is somewhat of a conical shape, the fore part rather broad and truncated, the lower part obtuse, and the whole covered with radiating bristles.

13. The *urinarium* is egg-shaped, with a short hairy beak.

14. The *semiluna* is smooth, pellucid, and shaped like a crescent.

15. The *trigona* is of a triangular shape, a little convex on both sides, the fore part acute and ciliated, the hind part broader, and having the extremity as it were gnawed off.

16. The *tinea* is round, not very pellucid, narrow in the fore part, and resembling an inverted club.

17. The *nigra* was found in salt water, and has an opaque body; but when at rest one side appears pellucid. When in violent motion, it seems entirely black.

18. The *pubes* is found in water where duckweed grows, chiefly in the month of December. It has a bunch above the hind part marked with black spots, depressed towards the top, a little folded, and somewhat convex on the under part. The apex is furnished with hairs, but they are seldom visible till the creature is in the agonies of death, when it extends and moves them vehemently, and attempting as it were to draw in the very last drop of water.

19. The *floccus* is membranaceous, the fore part rather conical, with three small hairy papillæ projecting from the base.

20. The *finuata* is found in river water. It is oblong and depressed, with one margin hollow and hairy, and the lower end obtuse. It is of a yellow colour, and the hollow edge ciliated.

21. The *præceps* is pellucid, the fore part formed into a kind of neck; one edge rising into a protuberance like a hump-back, the other edge convex.

22. The *proteus* is that which Mr Baker distinguishes by the same name, and of which an account is given under the article ANIMALCULE. It is found in the slimy matter adhering to the sides of vessels in which vegetables have been infused, or animal substances preserved. That described by Mr Adams was discovered in the slime produced from the water where small fishes, water-snails, &c. had been kept. The body resembled that of a snail, the shape being somewhat elliptical, but pointed at one end, while from the other proceeded a long, slender, and finely proportioned neck, of a size suitable to the rest of the animal.

23. The *versatilis* lives in the sea, and has some resemblance to the *proteus*; but the neck is shorter, the apex less spherical, and the hinder part of the trunk acute.

24. The *gibba* is pellucid; the upper part swelled out, with numerous molecules, and three large globules on the inside. The ends rather incline downwards; and when the water begins to fail, a few minute hairs may be discovered about the head and at the abdomen; the body then becomes striated longitudinally.

25. The *foeta* somewhat resembles a rolling-pin in shape; has both ends obtuse, and one shorter than the other. It can draw in the ends, and swell out the sides, so as to appear almost spherical.

26. The *patens* is found in salt water; and is of a long cylindrical shape, filled with molecules, the fore-part bright and clear, with a long opening near the top which tapers to a point, and is beset with hairs.

27. The *patula* is ventricose, rather inclining to an oval figure, with a small tube at the fore part, the upper part of which is hairy.

28. The *foveata* is oblong and rather broad, with three little horns on the fore part.

29. The *striata* is found in the month of December in river-water. It is a beautiful animalcule, of a fox colour. It is of an oblong shape, the lower end somewhat larger than the other. It has a set of streaks running from one end to the other, and at the abdomen a double row of little eggs lying in a transverse direction.

30. The *uvula* is found in the infusion of hay and other vegetables. It is six times longer than broad, round, flexuous, of an equal size, the greater part filled with obscure molecules; the fore part rather empty, with an alimentary canal and lucid globules near the middle. The margin of the fore part is covered with short hairs.

31. The *aurantia* is of a gold colour, pellucid, and filled with vesicles.

32. The *ignita* is of a fine purple colour, with something of a reddish cast, pellucid, splendid, with a number of globules of different sizes; the fore part small, the hinder part obtuse, with a very large opening which seems to run through the body.

33. The *prisma* is very small, and so transparent that it cannot easily be delineated. It is of a singular shape; the under part being convex, the upper compressed into a kind of keel, and the fore part small.

34. The *forceps* is found about the winter solstice in water covered with lemna. It is of a yellow colour, large, somewhat transparent, and filled with molecules, with a large opaque globule in the lower part. The fore part is divided into long lobes, one of which is falciform and acute, the other dilated and obliquely truncated. It can open, shut, or cross, those lobes at pleasure; and by the motion of them it appears to suck in the water.

35. The *forfex* is found in river water. It has the fore part formed into a kind of forceps, one of which is twice as long as the other, hooked and ciliated.

36. The *index* is found in salt water, and has the under part of the front of the margin hairy; the apex is formed by the fore part projecting like a finger on a direction post.

37. The *trichoda* is of a yellow colour, formed of two pellucid membranes striated longitudinally; the lower end obliquely truncated, and the two extremities bent in opposite directions.

38. The *navicula* has three corners; the fore part truncated and ciliated, the hind part acute and bent a little upwards. It has a crystalline appearance, and a kind of longitudinal keel runs down the middle.

39. The *succisa* is of a flattened oval shape, the edge hairy, and hollowed out in such a manner as to form two unequal legs.

40. The *fulcata* is ovated and ventricose, the apex acute, with a furrow at the abdomen, and both sides of it ciliated.

41. The *anas* is found in pure water; and is smooth,
five

Microscope five times broader than it is long, filled with darkish molecules. It has a bright neck, under the top of which are a few unequal hairs. It moves but languidly.

42. The *barbata* is round, somewhat linear, with both ends obtuse; the fore part narrower, forming as it were a kind of neck, under which is a row of fluctuating hairs. The trunk is full of grey molecules.

43. The *farcimen* is long, round, pellucid, and covered with very minute hairs, and has a great number of mucous vesicles about the body.

44. The *crinita* is long, round, every where ciliated on the upper part, and the under part likewise hairy as far as the middle.

45. The *angulus* is long, more convex than most of the genus, divided by a kind of articulation in the middle into two parts equal in breadth, but of different lengths; the apex has short waving hair.

46. The *linter* is found in an infusion of old grass. It is egg-shaped, oblong, with both extremities raised so that the bottom becomes convex, and the upper part depressed like a boat: it is of different shapes at different ages, and sometimes has a rotatory motion.

47. The *paxillus* is found in salt water; and is long, full of grey molecules; the fore part truncated and hairy, and rather smaller than the other.

48. The *vermicularis* is found in river water; and is pellucid in the fore part, with the hind part full of molecules.

49. The *melitea* is found in salt water, but very rarely. It is oblong, ciliated, with a globular apex, a dilatable neck, and a kind of peristaltic motion perceivable within it.

50. The *fimbriata* is subovated, the apex hairy, the hinder part obliquely truncated and serrated.

51. The *camelus* is found but rarely in vegetable infusions, and moves in a languid manner. The fore part is ventricose; the back divided by an incision in the middle into two tubercles; the lower part of the belly sinuated.

52. The *augur* is oblong, depressed, pellucid, and filled with molecules: the vertex is truncated, the fore part forming a small beak with three feet underneath; beyond which, toward the hinder part, it is furnished with bristles.

53. The *pupa* is roundish, pellucid, and consists of three parts. The head is broad, and appears to be hooded, the top being furnished with very small hairs; on the lower part of the head is a transparent vesicle, and over the breast from the base of the head hangs a production resembling the sheath of the feet in the pupa of the gnat.

54. The *lunaris* is round and crystalline; the hinder part smaller than the other. The edge of the back and the part near the tail are bright and clear. It bends itself into the form of an arch.

55. The *bilunis* is arched and flattened with an hairy apex, and two little bristles proceeding from the tail.

56. The *rattus* is oblong, with a kind of keel; the fore part hairy, and a very long bristle proceeding from the hinder part.

57. The *tigris* resembles the former, but differs in the form of the tail, which consists of two bristles, and likewise in having a kind of incision in the body a little below the apex.

58. The *perillum* is frequently found in marshes. It is cylindrical, pellucid, muscular, and capable of being folded up. It appears double; the interior part full of molecules, with an orbicular muscular appendage, which it can open and shut, and which forms the mouth. The external part is membranaceous, pellucid, dilated, and marked with transverse streaks; and it can protrude or draw in the orbicular membrane at pleasure. Some have four articulations in the tail, others five; and it has two pairs of bristles, one placed at the second joint, the other at the last.

59. The *clavus* has a considerable resemblance to a common nail; the fore part is round and hairy, the hinder part terminating in a sharp tail.

60. The *cornuta* is membranaceous, elliptical, full of molecules; the fore part lunated, the other round, and terminating in a tail as long as the body.

61. The *gallina* is found in river water. It is of a grey colour, flat, with seven large molecules and globules within it; the front obtuse, set with hairs; the hinder part terminating in a tail formed of very fine hairs.

62. The *musculus* is found in the infusions of hay which have been kept for some months. It is smooth, egg-shaped, with a double margin drawn underneath it; the fore part narrow, and furnished with short hairs which continually play about; having a small tail underneath. It moves slowly, and is furnished with molecular intestines.

63. The *delphis* is found in river water. It is smooth, pellucid, having the fore part dilated into a semicircle, gradually decreasing in breadth towards the tail. The front is hairy, the hairs standing as rays from the semicircular edge: one of the edges is sometimes contracted.

64. The *delphinus* is found in hay that has been infused for some months. It is pellucid, smooth, and egg-shaped; the hinder part terminating in a tail about half the length of the body, dilated at the upper end, truncated, and always bent upwards. It moves sometimes on its belly and sometimes on its side.

65. The *clava*, or club trichoda, has the fore part thick, but the hinder part narrow; both extremities obtuse, pellucid, and replete with molecules; the hind part bent down towards the middle.

66. The *cuniculus* is oblong, the fore part hairy, the hinder part rather acute, and filled with molecules and black vesicles.

67. The *felis* is large and curved, the fore part small, the hinder part gradually diminishing into a tail, the under part beset with hairs longitudinally.

68. The *piscis* is oblong, the fore part hairy, the hind part terminating in a very slender tail. It is smooth, pellucid, much longer than broad, and filled with yellow molecules; the fore part obtuse, the hinder part extremely slender and transparent, the upper side convex.

69. The *larus* is long, round, beset with hairs, and has the tail divided into two points.

70. The *longicauda* is cylindrical; the fore part truncated, and beset with hairs; the tail long, furnished with two bristles, and having two joints.

71. The *fixa* has the circumference set with hairs, and a little solitary pedicle projecting from the body.

72. The *inquilinus* is sheathed within a cylindrical transparent.

Microscope transparent bag, having a little pedicle bent back with-
in the bag.

73. The *ingenita* is sheathed in a depressed bag, broadest at the base. The animalcule itself is funnel-shaped, with one or more hairs proceeding from each side of the mouth of the funnel. It can extend or contract itself within the bag, fixing its tail to the base, without touching the sides. It is found in salt water.

74. The *innata* is sheathed in a cylindrical bag, with a pedicle passing through and projecting beyond it.

75. The *transfuga* is broad, the fore part hairy, the hinder part full of bristles; one side sinuated, and the other pointed.

76. The *ciliata* is ventricose, the hinder part covered with hair.

77. The *bullæ* is membranaceous, the sides bent inwards; the fore and hind parts both covered with hairs.

78. The *pellionella* is somewhat thick in the middle, and pellucid, with a few molecules here and there; the sides obtuse, the fore part ciliated with very fine hairs, the hinder part set with bristles.

79. The *cyllidium* has the hinder extremity filled with globules of various sizes. It vacillates upon the edge, commonly advancing on its flat side, and continually drawing in water. It then gapes, and opens into a very acute angle, almost to the middle of the body; but this is done so instantaneously, that it can scarce be perceived.

80. The *cursor* is oval, the fore part hairy, and the hinder part also furnished with some straight and curved hairs in two fascicles. Its body is flat, and filled with molecules; and in the fore part is an oblong empty space, into which we may sometimes see the water sucked in.

81. The *pulex* is egg-shaped, with an incision in the fore part; the front and base hairy.

82. The *lynceus* is nearly square, with a crooked beak and hairy mouth. It is membranaceous, and appears compressed, stretched out into a beak above, under which there is a little bundle of hairs; the lower edge bends in and out, and is surrounded with a few bristles. The intestines are beautiful, and a small bent tube goes from the mouth to them in the middle of the body. There is likewise another tube between the fore and hind edge, filled with blue liquor. The intestines and other tube are frequently in motion.

83. The *erosa* is orbicular, the fore part notched; one side furnished with hairs, the hinder part with bristles.

84. The *rostrata* is found in water where duckweed has been kept. It is depressed, capable of changing its shape, yellow, with long ciliated hairs; it has four feet tapering to a point, one of them longer than the rest. Both feet and hairs are within the margin. The shape of the body is generally triangular; the apex formed into an obtuse beak, which the creature sometimes draws in so that it appears quite round.

85. The *lagena* is round, ventricose, with a long neck, and the lower end set with bristles.

86. The *charon* was found in salt water. It is oval, and resembles a boat as well in its motion as shape: the upper part is hollowed, the under part furrowed
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and convex; the stern round, with several hairs proceeding from it.

87. The *cimex* is about the size of the lynceus, has an oval body, with a convex back, flat belly, and incision in the margin of the fore part, the edges of which incision appear to move. When this animalcule meets with any obstacles in swimming, it makes use of four bristles, which appear on the under side as feet.

88. The *cicada* differs but little from the cimex. It is oval, with an obscure margin, the fore part covered with hairs on the under side, and the hinder parts beardless.

XIV. Kerona.

An invisible worm with horns.

1. The *raffellum* is found in river water. It has three rows of horns on the back, which occupy almost the whole of it.

2. The *lynceaster* is square, and its disc furnished with shining horns.

3. The *histrion* appears an oblong membrane, pellucid, with four or five black points in the fore part, which are continually changing their situation, thick set with small globules in the middle, among which four larger ones are sometimes perceived, which by Mr Adams are supposed to be eggs. In the middle of the hind part are some longitudinal strokes resembling bristles, which, however, do not seem to project beyond the body.

4. The *cypris* is found in water covered with lemna. It is somewhat of a pear shape, compressed, with a broad and blunt fore part; the front furnished with hairs or little vibrating points inserted under the edge, shorter in the hind part, partly extended straight, and partly bent down, having a retrograde motion.

5. The *haustrium* is orbicular, with the horns in the middle, the fore part membranaceous and ciliated, with several bristles at the hinder part.

6. The *haustallum* differs from the preceding only in having the hinder part without any bristles.

7. The *patella* has an univalved shell, is orbicular, crystalline; the fore part somewhat notched; the fleshy body in the middle of the shell, with horns or hairs of different lengths jutting out beyond the shell, and acting instead of feet and oars, some of which are bent; and the superior ones constitute a double transverse row.

8. The *vannus* is oval and rather flat, with one edge bent, the opposite one ciliated, the front furnished with horns, and the hind part with bristles.

9. The *pullaster* agrees in many respects with the *trichoda pulex*; the upper part is pellucid, without any black molecules; the front truncated, the whole surface of the head covered with hair, and the fore part sinuous.

10. The *mytilus* is a large animalcule; the fore and hind parts rounded, very pellucid and white, dark in the middle, with black intestines intermixed with a few pellucid vesicles; both extremities appearing as if composed of two thin plates. It has two small horns, with which it agitates the water so as to form a little whirlpool.

11. The *lepus* is egg-shaped, compressed, pellucid, and

Microscope and crowned with short waving hairs; the base terminated with bristles.

12. The *filurus* is an oval, smooth, animalcule, somewhat crooked and opaque, with a fascicle of vibrating hair on the fore part: it has a sharp tail furnished with unequal rows of moveable hairs, the back being also ciliated: the hairs produce a rotatory motion. The figure varies from oval to oblong, and the filaments of the conferva are often entangled in the tail.

13. The *calvitium* is found in the infusion of vegetables. The body is broad and flat, both sides obtuse, filled with black molecules, and there is a black spot near the hinder part, where there are likewise a few short bristles.

14. The *pustulata* is found in salt water. It is oval, convex; one edge of the hinder part sinuated, both ends set with hairs, and some horns on the fore part.

XV. *Himantopus*:

A pellucid, invisible, and cirrated worm.

1. The *acarus* is lively, conical, ventricose, full of black molecules, with a bright and transparent fore part. The lower part of the apex has rows of long hairs on the under part set like rays. Four locks of long crooked hair or feet proceed from the belly, and it is continually moving these and other hairs in various directions.

2. The *ludio* is a lively diverting animalcule, smooth, pellucid, full of small points, the fore part clubbed and a little bent, the hinder part narrow; the base obliquely truncated, and terminating in a tail stretched out transversely. The top of the head and middle of the back are furnished with long and vibrating hairs; three moveable and flexible curls hang down from the side of the head at a distance from each other. When the creature is at rest, its tail is curled; but when in motion, it is drawn tight and extended upwards.

3. The *fannio* is found, though seldom, in water where the lemna grows. The cilia are longer than the hairs, and are continually vibrating: it has two moveable curls hanging on the side of the head.

4. The *volutator* is shaped like a crescent, and has some crystalline points; the convex part has a row of hairs longest towards the tail, and underneath are four feet. It is very lively, and often turns round with a swift circular motion.

5. The *larva* is long and cirrated in the middle; the body is depressed and long; the hinder parts acute, and generally curved, pellucid, and filled with granular molecules.

6. The *charon* is found in sea-water, but rarely. It is oval, pellucid, and membranous, with longitudinal furrows, and several bent diverging rows of hair below the middle, but none on the hinder part.

7. The *corona* is a membranous lamina, very thin, pellucid, crystalline, and semilunar: the edge of the base thick set with molecular intestines; the fore part furnished with a kind of mane; towards the hind part are three equal curved hairs or spines.

XVI. *Vorticella*:

A naked worm with rotatory cilia, capable of contracting and extending itself.

1. The *viridis* is visible to the naked eye, appearing

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like a small green point; but the microscope discovers it to be nearly cylindrical, a little thicker at the fore part than the other, and obtuse at both ends. It appears to be totally destitute of limbs, notwithstanding which it keeps the water in continual motion; so that it probably has some invisible rotatory instrument. It moves sometimes circularly, sometimes in a straight line.

2. The *spheroida* appears also like a point; but through the microscope as a globular mass of a dark green colour. It occasions a vehement motion in the water, probably by means of some short hairs with which it is furnished.

3. The *cincta* is of an irregular shape, sometimes assuming an oval figure, and appearing as if girt round with a transverse keel. It is invisible to the naked eye, ciliated on every side; the hairs all moveable, and longer on one side than the other.

4. The *lunifera* is found in salt water; has the fore-part obtuse, the base broad, and hollowed away like a crescent, with a short protuberance in the middle of the concave part: the fore part is ciliated.

5. The *burfata* is found in salt water, and is ventricose, crammed with molecules; the fore part truncated, and both sides of it pellucid: there is a prominent papilla in the middle, which when the animalcule is at rest appears notched, the edge of the aperture being ciliated; the hairs are capable of moving in various directions.

6. The *varia* is cylindrical, truncated, opaque, and blackish coloured; the fore part ciliated.

7. The *sputarium* is found in October, with the lesser lemna, and is one of the most singular of the microscopic animalcules. When viewed sidewise, it is sometimes nearly cylindrical, only tapering a little towards the hinder part, and having a broad pellucid edge. Viewed from the top, it has sometimes a broad face or disc, furnished with radiating hairs, the under part contracted into a globular shape, of a dark green colour, and filled with small grains.

8. The *polymorpha* is visible to the naked eye, and appears like a green point moving with great agility; but when viewed through a microscope, it assumes such a variety of forms, that it is impossible to describe them. The body is granulous; and a series of pellucid points is sometimes to be observed.

9. The *multiformis* is found in salt water, and very much resembles the former.

10. The *nigra* is found in August in meadows covered with water. It may be seen with the naked eye, appearing like a black point swimming on the surface. Through the microscope it appears as a small conical body, obtuse and ventricose at one end and acute at the other. When the extremities are extended, two small white hooks become visible, by the assistance of which it moves in the water, and it probably has a rotatory organ: it moves continually in a vacillating manner on the top of the water.

11. The *cucullus* is likewise visible to the naked eye: it is of a dirty red colour, of a shape somewhat conical, and resembling a grenadier's cap.

12. The *utriculata* is green and ventricose; the belly capable of being lengthened or shortened; the fore part truncated, much in the shape of a common water bottle;

Microscope bottle; the neck is sometimes very long, sometimes very short, and filled with green molecules.

13. The *ocrea* is met with in rivers, though very seldom, and in shape somewhat resembles the lower part of a boot. The apex of the upper part is truncated and ciliated, the heel pointed, and the foot round.

14. The *valga* is as broad as long, and the apex truncated and ciliated; both angles of the base projecting outwards, one somewhat like a wart, the other like a finger: It is found in marshy waters.

15. The *papillaris* is likewise found in marshes where the *conserva nitida* grows. It is ventricose; the fore part truncated, with a papillary tail, and a beautiful papillary excrescence on the side.

16. The *sacculus* is thick, of an equal diameter every where, and full of molecules. The edge of the mouth is bent back; the hinder part is obtuse, sometimes notched and contracted, with cilia to be seen on both sides of the mouth.

17. The *cirrata* is found in ditch-water. It is ventricose, the aperture sinuated, and two tufts of hair on each side of the belly.

18. The *nasuta* is invisible to the naked eye, but the microscope discovers it to be furnished with a rotatory organ encompassing the middle. It is pellucid, cylindrical, of an unequal size; the fore part truncated and ciliated, with a triangular prominence in the middle of the aperture; the hinder part is obtuse, with a point on each side of the middle of the body. When the water is nearly exhaled, two rotatory organs are observable; one on the fore part, and the other encompassing the middle of the body; the hairs of the latter being in violent motion. Other fascicles of moving hair are likewise to be observed; and the quick and various motions of this apparatus are very surprising.

19. The *stellina* is of an orbicular shape, with a molecular disc and ciliated margin.

20. The *discina* is likewise orbicular, the edge ciliated, with a kind of handle on the under side.

21. The *scyphina* is bowl-shaped, crystalline, with an opaque spherule in the middle.

22. The *albina* is cylindrical in the fore part, the hinder part tapering, and almost ending in a point.

23. The *fritillina* is empty and cylindrical, with a truncated apex.

24. The *truncatella* is of the larger kind of animalcules, with a crystalline body, full of black molecules, the skin perfectly smooth and colourless, the hinder extremity rounded, and the anterior part truncated: at this extremity there is a large opening that serves for a mouth, which is thickly ciliated.

25. The *limacina* is cylindrical, truncated, and has two pair of cilia.

26. The *fraxinina* is mostly cylindrical, the hinder part rather tapering, and full of opaque molecules; transparent towards the upper end. Within the edge at the top are two small tubercles, from each side of which proceeds a pair of small hairs.

27. The *cratægaria* is found in the month of April, both in the mud and on the tail of the monocus quadricornis. They are generally heaped together in a spherical form, and united to one common stalk. They are likewise often to be found without a pedicle, the body rather contracted, the aperture circular, and sur-

rounded with a marked margin. It has two small Microscope arms; and with a powerful magnifier a violent rotatory motion may be observed. Sometimes an individual will separate from the community, and move in a kind of spiral line for a little time, and then go back to the rest.

28. The *hamata* is not ciliated, nor has it any hairs upon it; the body is granulated, the fore part broad and truncated, the hinder part obtuse, and capable of being contracted or extended.

29. The *crateriformis* is a lively animalcule, pellucid, round, longer than it is broad, approaching somewhat to a square figure, with convex sides: the head is situated at the large end, the skin smooth, and some traces of intestines may be discovered with difficulty. There is a considerable opening surrounded by hair at the larger end, and the filaments composing it are in continual motion. Two of them are sometimes seen joined together, and full of small spherules. In this state they draw each other alternately different ways; the surface is smooth, and the hairs invisible.

30. The *canaliculata* appears to the naked eye as a number of white points adhering to the sides of the glass. When magnified, the fore part is narrower than the hind one; in the side is a kind of incision, and the hinder part is notched towards the middle. It excites a continual whirling motion in the water by means of a rotatory organ with which it is furnished.

31. The *versatilis* is a pellucid, gelatinous animalcule, of a greenish colour, and furnished with small radii about the circumference; so that it appears like a very small water hedge-hog.

32. The *ampulla* is contained in a transparent bottle-shaped bag; the head divided into two lobes. It sometimes lies at the bottom of the bag, and sometimes nearly fills the whole of it.

33. The *folliculata* is gelatinous and cylindrical; and when most extended, the base appears attenuated, and the apex truncated.

34. The *larva* is of a clay colour, the aperture ciliated, with a globular projection at times appearing to proceed from it.

35. The *sacculata* has the shape of an inverted cone, with an aperture in the figure of a crescent; the lower part of the trunk notched, forming as it were two teeth; the tail biphyllous. Each of these is surrounded with a loose bright skin, the head being divided from the trunk by a deep incision.

36. The *aurita* is cylindrical and ventricose, the aperture destitute of hairs; both sides of it are furnished with rotatory cilia, and the tail is biphyllous.

37. The *tremula* has something of a conical shape; the mouth being divided into parts which are set with small spines; and a point projects from the tail.

38. The *serita* is muscular, pellucid, folding variously; the fore part truncated; round the margin are rows of hairs; but it has also stiffer hairs or spines continually vibrating, with which it draws in all animate and inanimate substances which it is able to manage.

39. The *lacinulata* is shaped like an inverted cone, the aperture lobated, the tail small and furnished with two bristles. When swimming, the rotatory organ may be discovered. It moves swiftly in an oblique direction.

40. The

Microscope

40. The *constricta* is of two kinds; viz. of a pale yellow and of a white colour. They move by fixing their tail to the place where they are, and then extending their body as much as possible; fixing the fore part to the place to which they intend to move, then drawing the hinder part to it, and so on. Sometimes they turn round about upon one of the points of their tail; at other times they spring forwards with a jerk. When at rest they open their mouths very wide.

41. The *togata* has a convex body, filled with molecules, and of a dark colour; the hinder part somewhat broader than the forepart; the latter ciliated, and the tail formed of two very thin pellucid spines, which are somewhat curved, and much longer than the body.

42. The *rotatoria* is the *wheel animal* described by Mr Baker; and of which an account is given under the article ANIMALCULE.

43. The *furcata* is commonly found in water, and has a cylindric body with a rotatory organ, consisting of a row of hairs at the apex: the tail is divided into two parts, turning a little inwards. When at rest it joins the segments of the tail, but opens them when in motion.

44. The *catulus* is commonly found in marshy waters. It is a little thick muscular animalcule, folding itself up: equally broad throughout, the body disfigured by longitudinal folds, winding in various directions. The anterior part is connected to the body by a little neck; and it occasionally shows a small rotatory organ. Its motion is rotatory, but in various directions.

45. The *cunicula* is cylindrical, the aperture plain, with a short articulated tail divided into two parts.

46. The *felis* has a large body, the apex of an equal thickness, obtuse, with rotatory filaments: the tail is acute, with two pellucid spines in length about one-third part of the body, alternately separating from and approaching one another.

47. The *stentorea*. See the article POLYPE.

48. The *socialis*, when considerably magnified, appears like a circle surrounded with crowns or ciliated heads, tied by small thin tails to a common centre, from whence they advance towards the circumference, where they turn very briskly, occasioning a kind of whirlpool, which brings its food. When one of them has been in motion for a time, it stops and another begins; sometimes two or three may be perceived in motion at once: they are frequently to be met with separate, with the tail sticking in the mud. The body contracts and dilates very much, so as sometimes to have the appearance of a cudgel, at others to assume almost a globular form.

49. The *sosculosa* appears to the naked eye like a yellow globule adhering to the ceratophyllon like a little flower or a heap of yellow eggs. When magnified, they are seen to consist of a congeries of animalcula constituting a sphere from a mouldy centre. They contract and extend their bodies either alone or in society, and excite a vortex in the water by means of a disc. When they quit the society and act singly, they may be observed to consist of a head, abdomen, and tail; the head being frequently drawn back into the abdomen so far that it cannot be seen, only exhibiting a broad kidney-shaped disc standing out. The abdo-

men is oblong, oval, and transparent; the tail sharp, twice as long as the abdomen, sometimes rough and annulated, or altogether smooth.

50. The *citrina* is found in stagnant water; the head full of molecules, round, every where of an equal size, and very transparent. Both sides of the orifice are ciliated, and each has a rotatory motion appearing sometimes without and sometimes within the edge of the mouth.

51. The *piriformis* is somewhat oval, with a very small retractile foot, which it can draw within itself.

52. The *tuberosa* has a broad upper part, the under part small, with two projections at the anterior end, furnished with a number of fibrillæ, which produce a current of water by their vibration, and thus collect food for the animal.

53. The *ringens* is pear-shaped, pellucid, the middle of the aperture convex, both sides ciliated, the pedicle four times shorter than the body. It can contract the orifice to an obtuse point.

54. The *inclinans* has a pendulous, pellucid, little head; the anterior part truncated, and occasionally contracting itself twice as short as the pedicle. It is shaped like a tobacco-pipe.

55. The *vaginata* is erect, of the shape of a truncated egg; the pedicle is contained in a sheath.

56. The *globularia* is frequent among the cyclopa quadricorni. It has a small spherical head, the aperture of the mouth ciliated, the pedicle four times larger than the body, which it contracts into a spiral form.

57. The *lunaris* has a small goblet-shaped head, the margin of the orifice protuberant, ciliated on both sides, with undulating hairs, and the pedicle eight or ten times the length of the body. The pedicle extends itself as often as the mouth is opened, but is twisted up spirally when it is shut; and this is frequently repeated in a short space.

58. The *convallaria* is the same with the *bell-animal* mentioned by Mr Baker. See the article ANIMALCULE.

59. The *nutans* has a simple pedicle; twists itself spirally; is extremely slender, with a kind of cap on its head; the margin white and round, and seemingly encompassed with a lucid ring; the head diminishing towards the base.

60. The *nebulifera* is narrow at the base; open and truncated at the top; the margin seemingly surrounded with a ring: but, when the aperture is shut, the animalcule is of the shape of an egg, with a simple fetaceous pedicle, considerably longer than the body, and commonly much bent back.

61. The *annularis* is visible to the naked eye; the head an inverted cone, convex when the mouth is shut, but truncated when it is open; with a protuberant edge; the pedicle simple, very long, thick, and, whiter at the top than any where else; the apex twisted spirally.—When contracted, it appears to be annulated.

62. The *acinosa* inhabits that whitish substance which often entirely covers plants, wood, shells, &c. When this substance is examined by a microscope, it appears to be wholly composed of living animals of the polype kind. See POLYPE.

Microscope

63. The *fasciculata* has a rotatory organ, which may sometimes be seen projecting beyond the aperture; there is a little head at the apex, and the pedicle is twisted and very slender. A congealed green mass which is often found swimming about in ditches is composed of myriads of these animals, which are not visible to the naked eye, and when magnified appear like a bundle of green flowers.

64. The *bians* resembles a citron; the apex is truncated, the base narrow, and a gaping cleft is observable, descending from the apex to one third of the body.

65. The *bellis* is of a yellow colour, and much resembles the flower of a daisy; is ciliated round the margin of the head, and moves in a rotatory manner.

66. The *gemella* has a long pedicle, constantly furnished with two small heads.

68. The *pyraria*.

69. The *anastatica*.

70. The *digitalis*.

See the article POLYPE.

71. The *polypina*, when viewed through a small magnifier, they appear like so many little trees: the upper part, or heads, are egg-shaped, the top truncated, the lower part filled with intestines; the branches thick set with little knobs.

72. The *racemosa* is only distinguished from the *vorticella socialis* by always adhering to the sides of the vessel in which it is placed. By the microscope, we discover a long pedicle sticking to the sides of the vessels, from which proceed an innumerable quantity of crystalline pellucid pearls; which, together with the stalk, are variously agitated in the water. Sometimes they move separately; sometimes they are drawn down to the root, and in a moment expanded again.

XVII. *Brachionus*:

A contractile worm, covered with a shell, and furnished with rotatory cilia.

1. The *striatus* has an oblong, pellucid shell, capable of altering its figure. The apex is truncated, with six small teeth on the edge of it, twelve longitudinal streaks down the back, the base obtuse and smooth. The teeth are occasionally protruded or retracted; and there are two small spines or horns on the other side of the shell. The animal itself is of a yellow colour, crystalline, and muscular; now and then putting out from the apex two or three little bundles of playing hairs, the two lateral ones shorter than that in the middle: on the under side we may observe a forked deglutatory muscle, and two rigid points when the apex is drawn in. It is found in sea-water.

2. The *squamula* has an univalve orbicular shell, a truncated apex, four teeth, smooth base, and no tail.

3. The *pala* is of a yellow colour; univalved, with an oblong excavated shell; four long teeth at the apex; a smooth base.

4. The *bipalium* is univalved, the shell oblong and inflected, ten teeth at the apex, the base smooth, and a spurious tail.

5. The *patina* is extremely bright and splendid, has a large body, a crystalline and nearly circular shell, without either incision or teeth, only towards the apex it falls in so as to form a smooth notch. A double glittering organ, with ciliated edges, projects from the apex; both of them of a conical figure, and standing

as it were upon a pellucid substance, which is divided into two lobes, between which and the rotatory organ there is a silver-coloured crenulated membrane. Two small claws may likewise be discovered near the mouth.

6. The *clypeatus* is univalved, the shell oblong, apex notched, the tail naked, and base smooth.

7. The *lamellaris* is univalved; the shell extending considerably beyond the body; the base divided into three small horns, with two hairs at the end of the tail.

8. The *patella* is found in marshy water in the winter-time. It is univalve, the shell oval, plain, crystalline, with the anterior part terminating in two acute points on both sides, though the intervening space is commonly filled up with the head of the animal. By these points it fastens itself, and whirls about the body erect. The rotatory cilia are perceived with great difficulty.

9. The *braëa* is univalved, the shell somewhat orbicular, apex lunated, base smooth, and the tail furnished with two spines.

10. The *plicatilis* is univalved, with an oblong shell, the apex hairy, and base notched.

11. The *ovalis* is bivalved; the shell flattened, apex notched, a hollow part at the base, the tail formed of two tufts of hair.

12. The *tripos* is bivalved, the apex of the shell beardless, three horns at the base, and double tail. It fixes itself to objects by the filaments of the tail.

13. The *dentatus* is bivalved, with an arched shell; the apex and base are both toothed, and the tail formed of two spines.

14. The *mucronatus* is bivalved, somewhat of a square form; the base and apex pointed; the tail consisting of two spines.

15. The *uncinatus* is one of the smallest bivalved animalcules; the apex and anterior part round, the hinder part straight, terminating in a point, furnished with a hook on the fore part, a small rotatory organ, a long tail composed of joints, and divided at the end into two bristles. It can open its shell both at the fore and hind part.

16. The *cirratus* is larger than the preceding; ventricose, somewhat transparent, the head conical, with a bundle of hairs on both sides; and it has likewise a rotatory organ.

17. The *passus* has a cylindric shell, with two long pendulous locks of hair proceeding from the front, the tail consisting of a single bristle.

18. The *quadratus* has a quadrangular shell, with two small teeth at the apex, two horns proceeding from the base, and no tail.

19. The *impressus* has a quadrangular shell, a smooth undivided apex; obtuse base; notched margin; and flexuous tail.

20. The *urceolaris*. See POLYPE.

21. The *brachionus Bakeri* has a ventricose shell, four teeth at the apex, two horns at the base, and a long tail terminating in two short points. The horns are frequently extended; and the circular end of each is furnished with a tuft of little hairs, which sometimes move in a vibratory manner, at other times have a rotatory motion. Mr Muller has also discovered in this creature two small feelers and a tongue.

22. The *patulus* has a ventricose shell, with eight teeth

Microscopic Objects.
Fig. 38.

Plate CCCCII.

a

b

Fig. 33. Fig. 32.

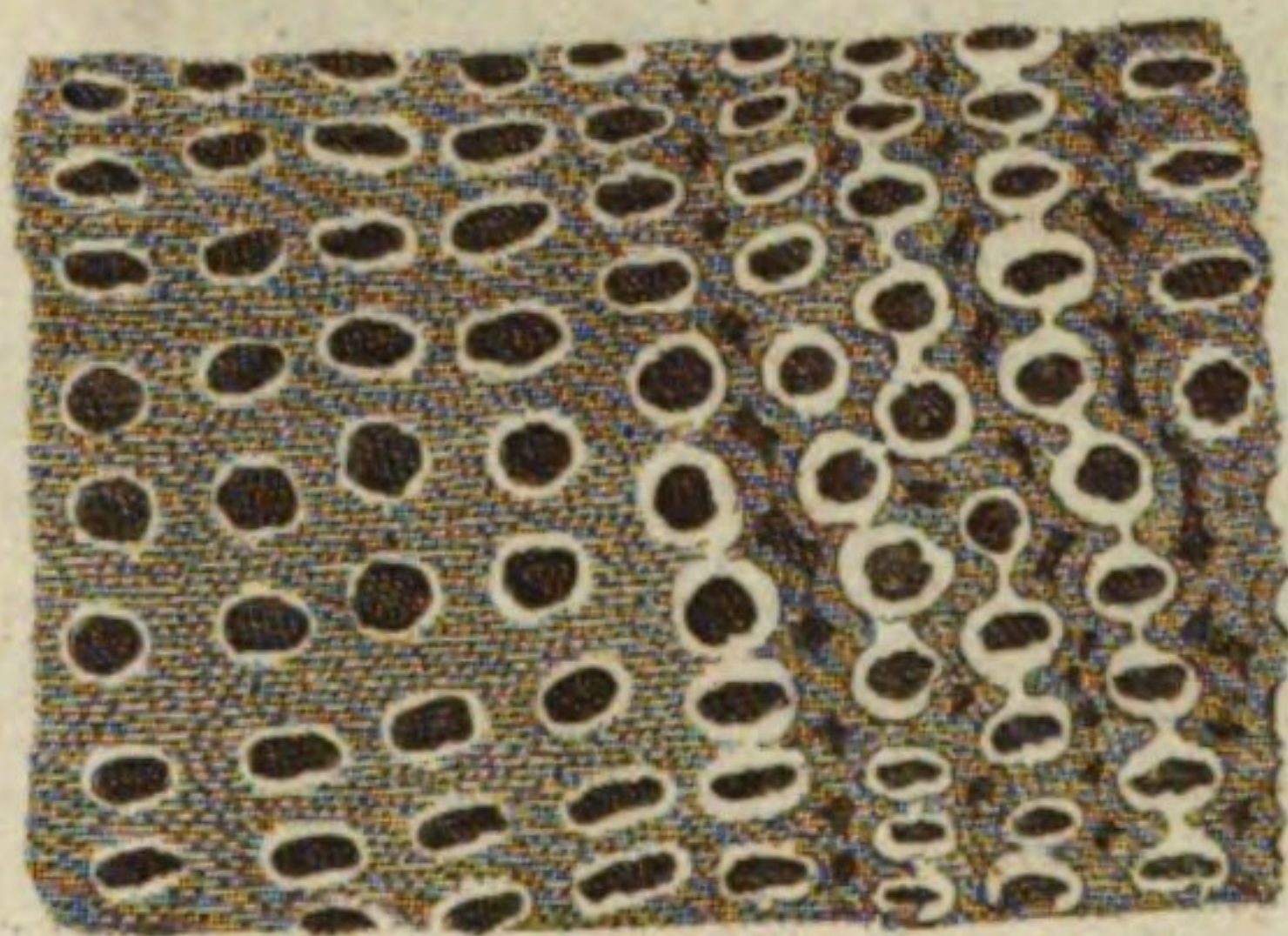


Fig. 35.



Fig. 36.



Fig. 39.



Fig. 37.



Fig. 40.



Fig. 41.



Fig. 34.



A. Bell. Pin. Wal. Sculptor fecit.

Microscope teeth at the apex; the base lunated, or hollowed into the form of a crescent, and furnished with four horns; the tail short, with two small points at the end.

THESE are the different kinds of animalcules which have yet been discovered. To what is said of them in general under the article ANIMALCULE, we shall here add the following observations from Mr Adams.—“How many kinds of these invisibles there may be (says he), is yet unknown; as they are discerned of all sizes, from those which are barely invisible to the naked eye, to such as resist the force of the microscope as the fixed stars do that of the telescope, and with the greatest powers hitherto invented appear only as so many moving points. The smallest living creatures our instruments can show, are those which inhabit the waters; for though animalcula equally minute may fly in the air, or creep upon the earth, it is scarce possible to get a view of them; but as water is transparent, by confining the creatures within it we can easily observe them by applying a drop of it to the glasses.

“Animalcules in general are observed to move in all directions with equal ease and rapidity, sometimes obliquely, sometimes straight forward; sometimes moving in a circular direction, or rolling upon one another, running backwards and forwards through the whole extent of the drop, as if diverting themselves; at other times greedily attacking the little parcels of matter they meet with. Notwithstanding their extreme minuteness, they know how to avoid obstacles, or to prevent any interference with one another in their motions: sometimes they will suddenly change the direction in which they move, and take an opposite one; and, by inclining the glass on which the drop of water is, as it can be made to move in any direction, so the animalcules appear to move as easily against the stream as with it. When the water begins to evaporate, they flock towards the place where the fluid is, and show a great anxiety and uncommon agitation of the organs with which they draw in the water. These motions grow languid as the water fails, and at last cease altogether, without a possibility of renewal if they be left dry for a short time. They sustain a great degree of cold as well as insects, and will perish in much the same degree of heat that destroys insects. Some animalcules are produced in water at the freezing point, and some insects live in snow.—By mixing the least drop of urine with the water in which they swim, they instantly fall into convulsions and die.

“The same rule seems to hold good in those minute creatures, which is observable in the larger animals, viz. that the larger kinds are less numerous than such as are smaller, while the smallest of all are found in such multitudes, that there seem to be myriads for one of the others. They increase in size, like other animals, from their birth until they have attained their full growth; and when deprived of proper nourishment, they in like manner grow thin and perish.”

The modes of propagation among these animalcules are various, and the observation of them is extremely curious. Some multiply by a transverse division, as is observed under the article ANIMALCULE: and it is re-

markable, that though in general they avoid one another, it is not uncommon, when one is nearly divided, to see another push itself upon the small neck which joins the two bodies in order to accelerate the separation.—Others, when about to multiply, fix themselves to the bottom of the water; then becoming first oblong, and afterwards round, turn rapidly as on a centre, but perpetually varying the direction of their rotatory motion. In a little time, two lines forming a cross are perceived; after which the spherule divides into four, which grow, and are again divided as before. A third kind multiply by a longitudinal division, which in some begins in the fore-part, in others in the hind-part; and from others a small fragment detaches itself, which in a short time assumes the shape of the parent animalcule. Lastly, others propagate in the same manner as the more perfect animals.

In our observations under the article ANIMALCULE, we suggested some doubts whether all those minute bodies which go under the name of *animalcules* really do enjoy animal life; or whether they are not in many cases to be accounted only inanimate and exceedingly minute points of matter actuated by the internal motion of the fluid. This has also been the opinion of others: but to all hypotheses of this kind Mr Adams makes the following reply. “From what has been said, it clearly appears, that their motions are not purely mechanical, but are produced by an internal spontaneous principle; and that they must therefore be placed among the class of living animals, for they possess the strongest marks and the most decided characters of animation; and, consequently, that there is no foundation for the supposition of a chaotic and neutral kingdom, which can only have derived its origin from a very transient and superficial view of these animalcules.—It may also be further observed, that as we see that the motions of the limbs, &c. of the larger animals, are produced by the mechanical construction of the body, and the action of the soul thereon, and are forced by the ocular demonstration which arises from anatomical dissection to acknowledge this mechanism which is adapted to produce the various motions necessary to the animal; and as, when we have recourse to the microscope, we find those pieces which had appeared to the naked eye as the primary mechanical causes of particular motions, to consist themselves of lesser parts, which are the causes of motion, extension, &c. in the larger; when the structure therefore can be traced no farther by the eye, or by the glasses; we have no right to conclude that the parts which are invisible are not equally the subject of mechanism: for this would be only to assert, in other words, that a thing may exist because we see and feel it, and have no existence when it is not the object of our senses.—The same train of reasoning may be applied to microscopic insects and animalcula: we see them move; but because the muscles and members which occasion these motions are invisible, shall we infer that they have not muscles, with organs appropriated to the motion of the whole and its parts? To say that they exist not because we cannot perceive them, would not be a rational conclusion. Our senses are indeed given us that we may comprehend some effects; but then we have also a mind, with reason, bestowed upon

Microscope upon us, that, from the things which we do perceive with our senses, we may deduce the nature of those causes and effects which are imperceptible to the corporeal eye."

Leaving these speculations however, we shall now proceed to give a particular

Explanation of the figures of the various animals, with their parts, ova, &c. represented in the plates.

Plate
CCCLII.

Fig. 32. 33. represent the eggs of the phalæna neustria, as they are taken from the tree to which they adhere, and magnified by the microscope. The strong ground-work visible in many places shows the gum by which they are fastened together; and this connection is strengthened by a very tenacious substance interposed between the eggs, and filling up the vacant spaces. Fig. 34. shows a vertical section of the eggs, exhibiting their oval shape.—Fig. 35. is an horizontal section through the middle of the egg. These eggs make a beautiful appearance through the microscope. The small figures *a, b, c*, represent the objects in their natural state, without being magnified.

Fig. 36. shows the larva of the *musca chameleon*, an aquatic insect. When viewed by the naked eye, it appears (as here represented) to be composed of twelve annular divisions, separating it into an head, thorax, and abdomen; but it is not easy to distinguish the two last parts from each other, as the intestines lie equally both in the thorax and abdomen. The tail is furnished with a fine crown or circle of hair *b*, disposed in the form of a ring, and by this means it is supported on the surface of the water, the head and body hanging down towards the bottom, in which posture it will sometimes remain for a considerable time without any motion.—When it has a mind to sink to the bottom, it closes the hairs of the ring, as in fig. 37. Thus an hollow space is formed, including a small bubble of air; by enlarging or diminishing which, it can rise or sink in the water at pleasure. When the bubble escapes, the insect can replace it from the pulmonary tubes, and sometimes considerable quantities of air may be seen to escape from the tail of the worm into the common atmosphere; which operation may easily be observed when the worm is placed in a glass of water, and affords an entertaining spectacle. The snout of this insect is divided into three parts, of which that in the middle is immoveable; the other two, which grow from the sides of the middle one, are moveable, and vibrate like the tongues of lizards or serpents. In these lateral parts lies most of the creature's strength; for it walks upon them when out of the water, appearing to walk on its mouth, and to use it as the parrot does its beak to assist it in climbing.

The larva is shown fig. 38. as it appears through a microscope. It grows narrower towards the head, is largest about that part which we may call the thorax, converges all along the abdomen, and terminates at length in a sharp tail surrounded with hairs, as has already been mentioned. The twelve annular divisions are now extremely visible, and are marked by numbers in the plate. The skin appears somewhat hard, and resembling shagreen, being thick set with grains pretty equally distributed. It has nine holes, or spiracula, probably for the purpose of breathing, on each side;

but it has none of these on the tail division *a*, nor any easily visible on the third from the head. In the latter, indeed, it has some very small holes concealed under the skin, near the place where the embryo wings of the future fly are hid. "It is remarkable (says Mr Adams) that caterpillars, in general, have two rings without these spiracula, perhaps because they change into flies with four wings, whereas this worm produces a fly with only two." The skin of the larva is adorned with oblong black furrows, spots of a light colour, and orbicular rings, from which there generally springs a hair; but only those hairs which grow on the insect's sides are represented in the figure. There are also some larger hairs here and there, as at *cc*. The difference of colour, however, in this worm arises only from the quantity of grains in the same space; for where they are in very great numbers, the furrows are darker, and paler where they are less plentiful.

The head *d* is divided into three parts, and covered with a skin which has hardly any discernible grains.—The eyes are rather protuberant, and lie near the snout; on which last are two small horns at *ii*. It is crooked, and ends in a sharp point as at *f*. The legs are placed near the snout between the sinuses in which the eyes are fixed. Each of these legs consists of three joints, the outermost of which is covered with stiff hairs like bristles *gg*. From the next joint there springs a horny bone *bb*, used by the insect as a kind of thumb: the joint is also composed of a black substance of an intermediate hardness between bone and horn; and the third joint is of the same nature. In order to distinguish these parts, those that form the upper sides of the mouth and eyes must be separated by means of a small knife; after which, by the assistance of the microscope, we may perceive that the leg is articulated by some particular ligaments, with the portion of the insect's mouth which answers to the lower jaw in the human frame. We may then also discern the muscles which serve to move the legs, and draw them up into a cavity that lies between the snout and those parts of the mouth which are near the horns *ii*. The insect walks upon these legs, not only in the water, but on the land also. It likewise makes use of them in swimming, keeping its tail on the surface contiguous to the air, and hanging downward with the rest of the body in the water. In this situation, the only perceptible motion it has is in its legs, which it moves in a most elegant manner, from whence it is reasonable to conclude, that the most of this creature's strength lies in its legs, as we have already observed.

The snout of this larva is black and hard; the back part quite solid, and somewhat of a globular form; the front *f* sharp and hollow. Three membranaceous divisions may be perceived on the back part; by means of which, and the muscles contained in the snout, the creature can contract or expand it at pleasure.

The extremity of the tail is surrounded with thirty hairs, and the sides adorned with others that are smaller; and here and there the large hairs branch out into smaller ones, which may be reckoned single hairs. All these have their roots in the outer skin, which in this place is covered with rough grains, as may be observed by cutting it off and holding it against the light upon

Microscope upon a slip of glass. Thus also we find, that at the extremities of the hairs there are grains like those on the skin; and in the middle of the tail there is a small opening, within which are minute holes, by which the insect takes in and lets out the air it breathes. These hairs, however, are seldom disposed in such a regular order as is represented in fig. 38. unless when the insect floats with the body in the water, and the tail with its hairs a little lower than the surface, in which case they are disposed exactly in the order delineated in the plate. The least motion of the tail downward produces a concavity in the water; and it then assumes the figure of a wine-glass, wide at the top and narrow at the bottom. The tail answers the double purpose of swimming and breathing, and through it the insect receives what is the principle of life and motion to all animals. By means of these hairs also it can stop its motion when swimming, and remain suspended quietly without motion for any length of time. Its motions in swimming are very beautiful, especially when it advances with its whole body floating on the surface of the water after filling itself with air by the tail.—To set out, it first bends the body to the right or left, and then contracts it in the form of the letter S, and again stretches it out in a straight line: by thus contracting and then extending the body alternately, it moves on the surface of the water. It is very quiet, and is not disturbed by handling.

These creatures are commonly found in shallow standing waters in the beginning of June; but some years much more plentifully than others. They crawl on the grass and other plants which grow in such waters, and are often met with in ditches floating on the surface of the water by means of their tail, the head and thorax at the same time hanging down; and in this posture they turn over the clay and dirt with their snout and feet in search of food, which is commonly a viscous matter met with in small ponds and ditches. It is very harmless, though its appearance would seem to indicate the contrary. It is most easily killed for dissection by spirit of turpentine.

Fig. 39. shows in its natural size a beautiful insect, described by Linnæus under the name of *Leucopis dorfigera*, and which appears to be a kind of intermediate genus between a sphex and a wasp. The antennæ are black and cylindrical, increasing in thickness towards the extremity; the joint nearest the head is yellow; the head and thorax are black, encompassed with a yellow line, and furnished with a cross line of the same colour near the head. The scutellum is yellow, the abdomen black, with two yellow bands, and a deep spot of the same colour on each side between the bands. A deep polished groove extends down the back from the thorax to the anus, into which the sting turns and is deposited, leaving the anus very circular; a yellow line runs on each side of the sting.—The anus and whole body, when viewed with a small magnifier, appear punctuated; but when these points are seen through a large magnifier, they appear hexagonal. Fig. 40. shows the insect very much magnified. Fig. 41. gives a side view of it magnified in a smaller degree.

Fig. 42. shows an insect lately discovered by Mr John Adams of Edmonton, as he happened to be at

an inn. It was first seen by some labouring people who were there at the time, by whom it was conjectured to be a louse with unusually long horns, a mite, &c. Mr Adams hearing the debate, procured the insect; and having viewed it through a microscope, it presented the appearance exhibited in fig. 42. The insect seems to be quite distinct from the phalangium cancroides of Linnæus. The latter has been described by several authors, but none of their descriptions agree with this. The abdomen of this insect is more extended, the claws larger, and much more obtuse; the body of the other being nearly orbicular, the claws slender, and almost terminating in a point, more transparent, and of a paler colour. Mr Marsham has one in his possession not to be distinguished from that represented in fig. 42, excepting only that it wants the break or dent in the claws, which is so conspicuous in this. He found that insect firmly fixed by its claws to the thigh of a large fly, which he caught on a flower in Essex in the first week of August, and from which he could not disengage it without great difficulty, and tearing off the leg of the fly. This was done upon a piece of writing paper; and he was surprised to see the little creature spring forward a quarter of an inch, and again seize the thigh with its claws, so that he had great difficulty in disengaging it. The natural size of this creature, which Mr Adams calls the *lobster-insect*, is exhibited at *a*.

Fig. 43. shows the insect named by M. de Geer *Physapus*, on account of the bladders at its feet, (*Thrips physapus*, Lin.). This insect is to be found in great plenty upon the flowers of dandelion, &c. in the spring and summer. It has four wings, two upper and two under ones (represented fig. 44.) but the two undermost are not to be perceived without great difficulty. They are very long; and fixed to the upper part of the breast, lying horizontally. Both of them are rather pointed towards the edges, and have a strong nerve running round them, which is set with a hair fringe tufted at the extremity. The colour of these wings is whitish: the body of the insect is black; the head small, with two large reticular eyes. The antennæ are of an equal size throughout, and divided into six oval pieces, which are articulated together.—The extremities of the feet are furnished with a membranaceous and flexible bladder, which it can throw out or draw in at pleasure. It presses this bladder against the substances on which it walks, and thus seems to fix itself to them; the bladder sometimes appears concave towards the bottom, the concavity diminishing as it is less pressed. The insect is represented of its natural size at *b*.

Fig. 45. represents the *Cimex strigatus* of Linnæus, remarkable for very bright and elegantly disposed colours, though few in number. The head, proboscis, and thorax, are black: the thorax ornamented with yellow spots; the middle one large, and occupying almost one-third of the posterior part; the other two are on each side, and triangular. The scutellum has two yellow oblong spots, pointed at each end. The ground of the elytra is a bright yellow, spotted and striped with black. The nerves are yellow; and there is a brilliant triangular spot of orange, which unites the crustaceous and membranaceous

Microscope ceous parts; the latter are brown, and clouded. It is found on the elm-tree in June. It is represented of its natural size at *c*.

Fig. 46. shows the *Chrysomela asparagi* of Linnæus, so called from the larva of the insect feeding upon that plant. It is a common insect, and very beautiful. It is of an oblong figure, with black antennæ, composed of many joints, nearly oval. The head is a deep and bright blue; the thorax red and cylindrical: the elytra are blue, with a yellow margin, and having three spots of the same colour on each; one at the base, of an oblong form, and two united with the margin: the legs are black; but the under side of the belly is of the same blue colour with the elytra and head. This little animal, when viewed by the naked eye, scarcely appears to deserve any notice; but when examined by the microscope, is one of the most pleasing opaque objects we have. It is found in June on the asparagus after it has run to seed; and it is shown of its natural size at *d*. De Geer says that it is very scarce in Sweden.

Fig. 47. shows an insect of a shape so remarkable, that naturalists have been at a loss to determine the genus to which it belongs. In the Fauna Suecica, Linnæus makes it an *attelabus*; but in the last edition of the Systema Naturæ, it is ranged as a me-loe, under the title of the *Meloe monoceros*; though of this also there seems to be some doubt. The true figure of it can only be discovered by a very good microscope. The head is black, and appears to be hid or buried under the thorax, which projects forward like a horn: the antennæ are composed of many joints, and are of a dirty yellow colour, as well as the feet: the hinder part of the thorax is reddish, the fore-part black.—The elytra are yellow, with a black longitudinal line down the future; there is a band of the same colour near the apex, and also a black point near the base, the whole animal being curiously covered with hair. The natural size of it is shown at *e*. It was found in May. Geoffroy says that it lives upon umbelliferous plants.

Fig. 48—53. exhibit the anatomy of the coxus caterpillar, which lives on the willow. The egg from which it proceeds is attached to the trunk of the tree by a kind of viscous juice, which soon becomes so hard that the rain cannot dissolve it. The egg itself is very small and spheroidal, and, when examined by the microscope, appears to have broad waving furrows running through the whole length of it, which are again crossed by close streaks, giving it the appearance of a wicker basket. It is not exactly known what time they are hatched; but as the small caterpillars appear in September, it is probable that the eggs are hatched some time in August. When small, they are generally met with under the bark of the tree to which the eggs were affixed; and an aqueous moisture, oozing from the hole through which they got under the bark, is frequently, though not always, a direction for finding them. These caterpillars change their colour but very little, being nearly the same when young as when old. Like many others, they are capable of spinning as soon as they come from the egg. They also change their skin several times; but as it is almost impossible to rear them under a glass, so it is very difficult to know exactly how often this moulting takes place.—Mr Adams conjectures that it is more frequently than

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the generality of caterpillars do, some having been *Microscope* observed to change more than nine times.

The coxus generally fasts for some days previous to the moulting; during which time the fleshy and other interior parts of the head are detached from the old skull, and retire as it were within the neck. The new coverings soon grow on, but are at first very soft.—When the new skin and the other parts are formed, the old skin is to be opened, and all the members withdrawn from it; an operation naturally difficult, but which must be rendered more so from the soft and weak state of the creature at that time. It is always much larger after each change.

From Mr Lyonet's experiments, it appears, that the coxus generally passes at least two winters, if not three, before it assumes the pupa state. At the approach of winter, it forms a little case, the inside of which is lined with silk, and the outside covered with wood ground like very fine saw-dust. During the whole season it neither moves nor eats.

This caterpillar, at its first appearance, is not above one-twelfth of an inch long; but at last attains the length of two, and sometimes of three inches. In the month of May it prepares for the pupa state; the first care being to find a hole in the tree sufficient to allow the moth to issue forth; and if this cannot be found, it makes one equal in size to the future pupa. It then begins to form of wood a case or cone; uniting the bits, which are very thin, together by silk, into the form of an ellipsoid, the outside being formed of small bits of wood joined together in all directions; taking care, however, that the pointed end of the case may always be opposite to the mouth of the hole: having finished the outside of the case, it lines the inside with a filken tapestry of a close texture in all its parts, except the pointed end, where the texture is looser, in order to facilitate its escape at the proper time. The caterpillar then places itself in such a posture, that the head may always lie towards the opening of the hole in the tree or pointed end of its case. Thus it remains at rest for some time: the colour of the skin first becomes pale, and afterwards brown; the interior parts of the head are detached from the skull; the legs withdraw themselves from the exterior case; the body shortens; the posterior part grows small, while the anterior part swells so much, that the skin at last bursts; and, by a variety of motions, is pushed down to the tail; and thus the pupa is exhibited, in which the parts of the future moth may be easily traced.—The covering of the pupa, though at first soft, humid, and white, soon dries and hardens, and becomes of a dark purple colour: the posterior part is moveable; but not the fore-part, which contains the rudiments of the head, legs, and wings. The fore-part of the pupa is furnished with two horns, one above and the other under the eyes. It has also several rows of points on its back. It remains for some weeks in the case; after which the moth begins to agitate itself, and the points are then of essential service, by acting as a fulcrum, upon which it may rest in its endeavours to proceed forward, and not slip back by its efforts for that purpose.

The moth generally continues its endeavours to open the case for a quarter of an hour; after which, by redoubled efforts, it enlarges the hole, and presses forward

Microscopic Objects.

Plate CCCIII.

Fig. 54.



Fig. 42



Fig. 43.

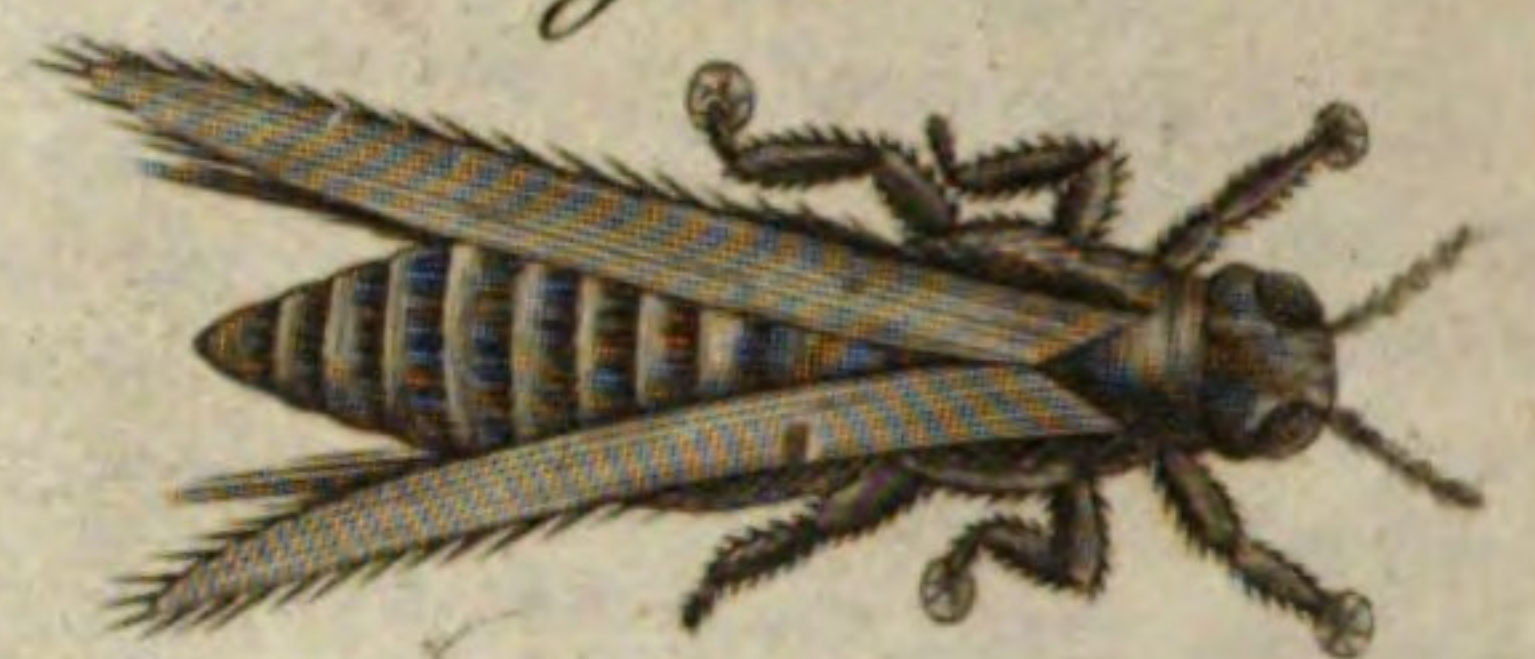


Fig. 44.

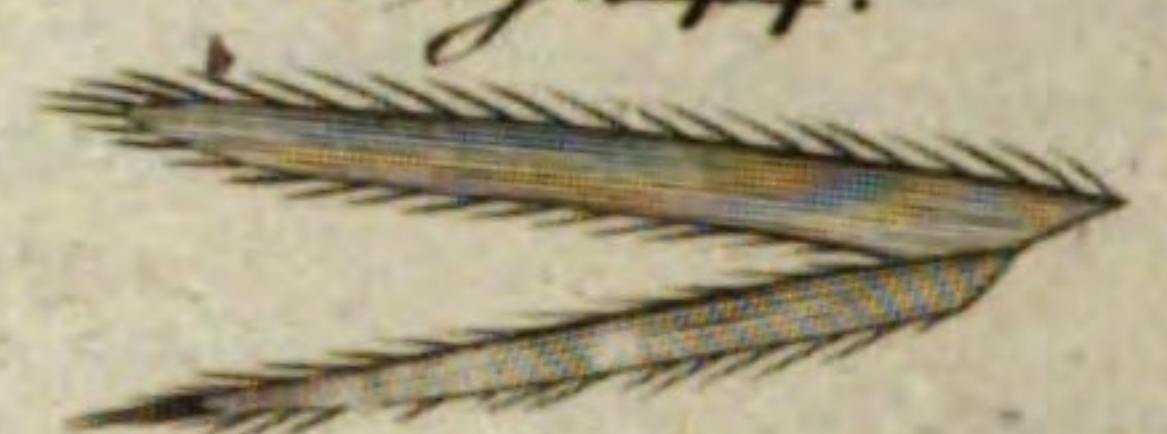


Fig. 46.



Fig. 53. Fig. 52.



Fig. 45.



Fig. 47.



Fig. 51. Fig. 50.

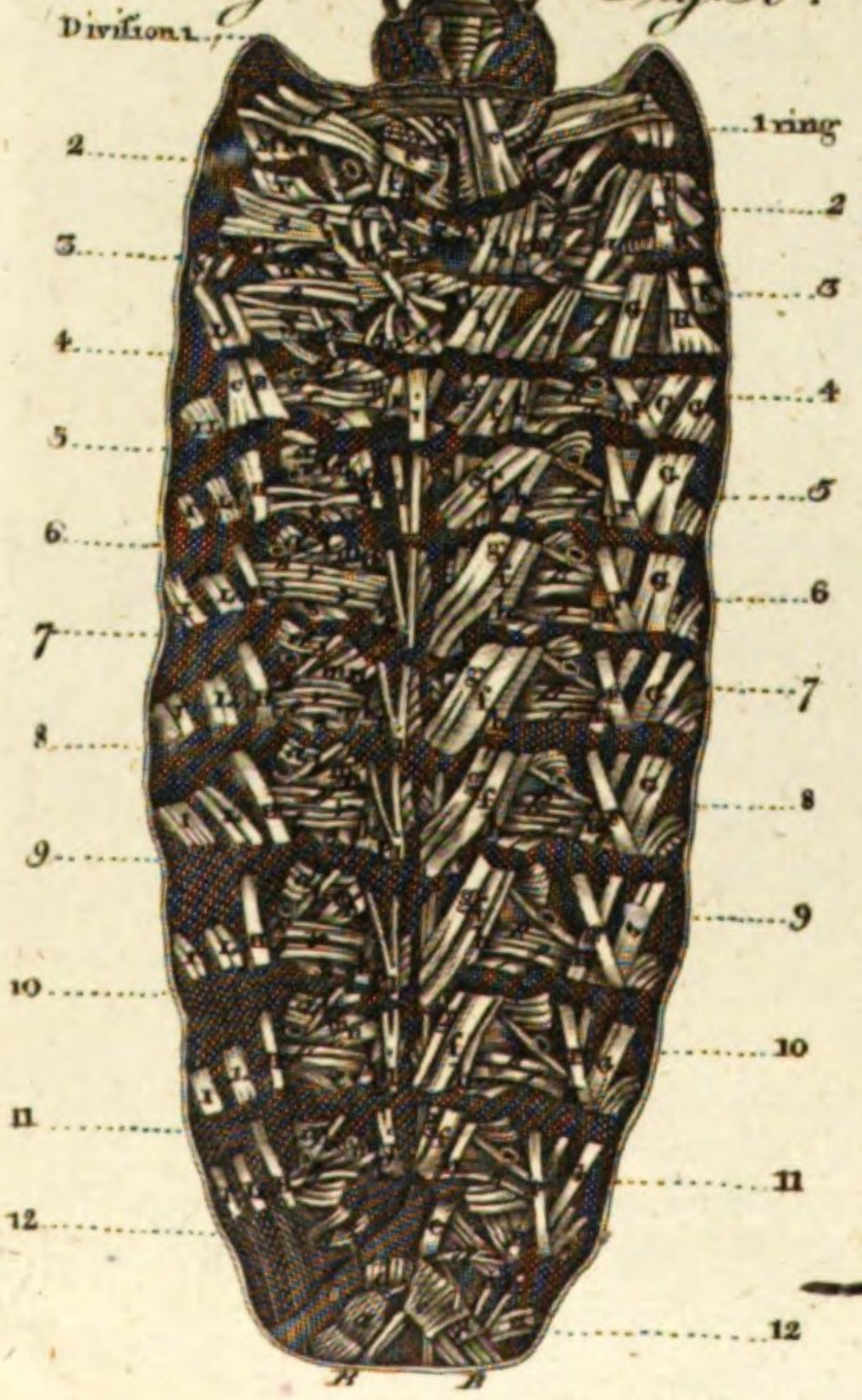
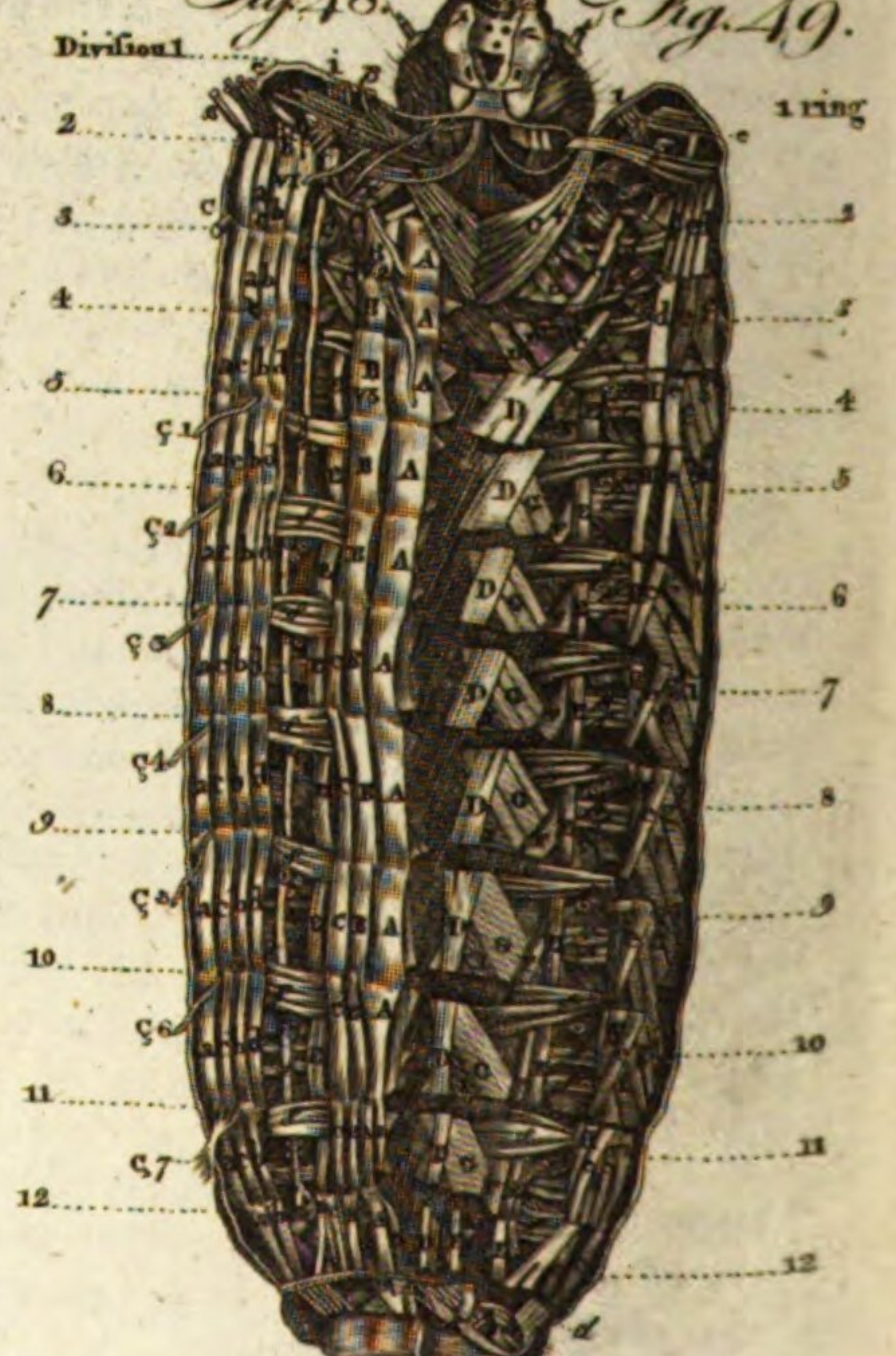


Fig. 48. Fig. 49.



Microscope ward until it arrives at the edge, where it makes a full stop, lest by advancing further it should fall to the ground. After having in this manner reposed itself for some time, it begins to disengage itself entirely; and having rested for some hours with its head upwards, it becomes fit for action. Mr Marsham says, that it generally pushes one third of the case out of the hole before it halts.

The body of the caterpillar is divided into twelve rings, marked 1, 2, 3, &c. as represented in fig. 48. 49. 50. 51. each of which is distinguished from that which precedes, and that which follows, by a kind of neck or hollow; and, by forming boundaries to the rings, we make twelve other divisions, likewise expressed in the figures; but to the first of these the word *ring* is affixed, and to the second, *division*. To facilitate the description of this animal, M. Lyonet supposed a line to pass down through the middle of the back, which he called the superior line, because it marked the most elevated part of the back of the caterpillar; and another, passing from the head down the belly to the tail, he called the inferior line.

All caterpillars have a small organ, resembling an elliptic spot, on the right and left of each ring, excepting the second, third, and last; and by these we are furnished with a further subdivision of this caterpillar, viz. by lines passing through the spiracula, the one on the right side, the other on the left of the caterpillar. These four lines, which divide the caterpillar longitudinally into four equal parts, mark each the place under the skin which is occupied by a considerable viscus. Under the superior line lies the heart, or rather thread of hearts; over the inferior line, the spinal marrow; and the two tracheal arteries follow the course of the lateral lines. At equal distances from the superior and two lateral lines, we may suppose four intermediate lines. The two between the superior and lateral lines are called the intermediate superior; the two others opposite to them, and between the lateral and inferior lines, are called the intermediate inferior.

Fig. 48. 49. show the muscles of the caterpillar, arranged with the most wonderful symmetry and order, especially when taken off by equal strata on both sides, which exhibits an astonishing and exact form and correspondence in them. The figures show the muscles of two different caterpillars opened at the belly, and supposed to be joined together at the superior lines. The muscles of the back are marked by capitals; the gastric muscles by Roman letters; the lateral ones by Greek characters. Those marked θ are called, by M. Lyonet, dividing muscles, on account of their situation.

The caterpillar was prepared for dissection by being emptied, and the muscles, nerves, &c. freed from the fat in the manner formerly directed: after which the following observations were made.

The muscle A in the first ring is double; the anterior one being thick at top, and being apparently divided into different muscles on the upper side, but without any appearance of this kind on the under side. One insertion is at the skin of the neck towards the head; the other is a little above; and that of the second muscle A is a little below the first spiraculum, near which they are fixed to the skin.

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The muscle marked α is long and slender, fixed by its anterior extremity under the gastric muscles a and b of the first ring, to the circumflex scale of the base of the lower lip. It communicates with the muscle c of the second ring, after having passed under some of the arteries, and introduced itself below the muscle ϵ .

The muscle β is so tender, that it is scarce possible to open the belly of the caterpillar without breaking it. It is sometimes double, and sometimes triple.—Anteriorly it is fixed to the posterior edge of the side of the parietal scale, the lower fixture being at the middle of the ring near the inferior line.

There are three muscles marked ζ ; the first affixed at one extremity near the lower edge of the upper part of the parietal scale; the other end divides itself into three or four tails, fixed to the skin of the caterpillar under the muscle δ . The anterior part of the second is fixed near the first; the anterior part of the third a little under the first and second, at the skin of the neck under the muscle A. These two last passing over the cavity of the first pair of limbs, are fixed by several tails to the edge opposite to this cavity. In this subject there are two muscles marked ι , but sometimes there is only one anteriorly; they are fixed to the lower edge of the parietal scale, the other ends being inserted in the first fold of the skin of the neck on the belly-side. Fig. 50. best represents the muscles β and δ ; as in that figure they do not appear injured by any unnatural connection.

In the second and four following rings we discern two large dorsal muscles A and B. In the 7th, 9th, and 10th rings are three, A, B, and C; in the 11th are four, A, B, C, and D; and in the anterior part of the 12th ring are five, A, B, C, D, and E. All these ranges of muscles, however, as well as the gastric muscles a, b, c, d , appear at first sight only as a single muscle, running nearly the whole length of the caterpillar; but when this is detached from the animal, it is found to consist of so many distinct muscles, each consisting only of the length of one of the rings, their extremities being fixed to the division of each ring, excepting the middle muscle a , which, at the 6th, 7th, 8th, and 9th rings, has its insertions rather beyond the division. Each row of muscles appears as one, because they are closely connected at top by some of the fibres which pass from one ring to the other.

The muscles A, which are 12 in number, gradually diminish in breadth to the lower part of the last ring: at the 8th and three following divisions they communicate with the muscles B, and at the 11th with D. In the lower part of the last ring, A is much broader than it was in the preceding ring; one extremity of it is contracted, and communicates with B; the lower insertion being at the membrane I, which is the exterior skin of the fecal bag. The muscles A and B, on the lower part of the last ring, cannot be seen until a large muscle is removed, which on one side is fixed to the subdivision of the ring and on the other to the fecal bag.

The right muscles B, which are also 12 in number, begin at the second ring, and grow larger from thence to the seventh. They are usually narrower from thence to the 12th; the deficiency in width being

Microscope ing supplied by the six muscles C, which accompany it from the 7th to the subdivision of the 12th ring. The muscles B and C communicate laterally with the 8th, 11th, and 12th divisions. C is wanting at the subdivision of the 12th; its place being here supplied by B, which becomes broader at this part.

The first of the three floating muscles V originates at the first ring, from whence it introduces itself under N, where it is fixed, and then subdivides, and hides itself under other parts. The second begins at the second division, being fixed to the anterior extremity B of the second ring; from thence directing itself towards the stomach; and, after communicating with the case of the *corpus crassum*, it divides, and spreads into eight muscles which run along the belly. The third begins at the third division, originating partly at the skin, and partly at the junction of the muscles B of the second and third ring. It directs itself obliquely towards the belly, meeting it near the third spiraculum; and branching from thence, it forms the oblique muscles of some of the viscera.

The thin, long, muscle θ , which is at the subdivision of the last ring, and covers the anterior insertion of the muscle (a) where the ring terminates, is single. It begins at one extremity of the muscle (c); at the fore-part of the ring runs along the subdivision round the belly of the caterpillar, and finishes, on the other side, at the extremity of a similar muscle C.

Fig. 49. shows the dorsal muscles of the coxus. To view which in an advantageous manner, we must use the following mode of preparation.

1. All the dorsal muscles, 35 in number, must be taken out, as well as the seven lateral ones already described.

2. All the straight muscles of the belly must be taken away, as well as the muscular roots (c), and the ends of the gastric muscles (c), which are at the third and fourth divisions.

3. At the second division the muscle θ must be removed; only the extremities being left to show where it was inserted.

The parts being thus prepared, we begin at the third ring; where there are found four dorsal muscles C, D, E, and F. The first one C, is inserted at the third division, under the muscles θ and α , where it communicates by means of some fibres with the muscle f of the second ring; proceeding from thence obliquely towards the intermediate superior line, and is fixed at the fourth division. As soon as C is retrenched, the muscle D is seen; which grows wider from the anterior extremity: it lies in a contrary direction to the muscle C, and is inserted into the third and fourth divisions. The muscle E lies in the same direction as the muscle C, but not so obliquely: the lower insertion is at the fourth division; the other at the third, immediately under C. The muscle F is nearly parallel to D which joins it; the first insertion is visible, but the other is hid under the muscles E and G at the fourth division.

In the eight following rings, there are only two dorsal muscles; and of these D is the only one that is completely seen. It is very large, and diminishes gradually in breadth from one ring to the other, till it comes to the last, sending off branches in some

places.—E is one of the flat muscles of the back; *Microscope* and is inserted under the dividing muscles θ , at the divisions of its own ring.

On the anterior part of the 12th ring there are three dorsal muscles, D, E, and F. D is similar to that of the preceding ring, marked also D, only that it is no more than half the length; terminating at the subdivision of its own ring. E is of the same length, and differs from the muscle E of the preceding ring only in its direction. F is parallel to E, and shorter than it; its anterior end does not reach the twelfth division.

On the posterior part there is only one dorsal muscle, fastened by some short ones to the subdivision of the last ring, traversing the muscles α ; and being fixed there as if designed to strengthen them, and to vary their direction.— α is a single muscle, of which the anterior insertion is visible, the other end being fixed to the bottom of the foot of the last leg; its use is to move the foot. The anterior part of the muscle β branches into three or four heads, which cross the superior line obliquely, and are fixed to the skin a little above it. The other end is fastened to the membrane T.

Fig. 50. and 51. show the muscles of the caterpillar when it is opened at the back. The preparation for this view is to disengage the fat and other extraneous matter, as before directed.

The first ring has only two gastric muscles (c) and (d): the former is broad, and has three or four little tails: the first fixture is at the base of the lower lip, from whence it descends obliquely, and is fixed between the inferior and lateral line. The small muscle (d) is fastened on one side to the first spiraculum; on the other, a little lower, to the intermediate inferior and lateral line; and seems to be an antagonist to the muscle P, which opens the spiracula. The posterior fixture of δ is under the muscle C, near the skin of the neck: β is fixed a little on the other side of C, at the middle of the ring.

In the second ring there are three gastric muscles, g, h, and i: g and h are fixed at the folds which terminate the ring; but only the anterior part of i is fixed there. The muscle h is triple, and in one of the divisions separated into two parts; that marked i comes nearer the inferior line, and is fixed a little beyond the middle of the ring, where the corresponding muscle of the opposite side is forked to receive it.

In the third ring, the muscle h, which was triple in the foregoing ring, is only double here, that part which is nearest the inferior line being broadest: it has three tails, of which only two are visible in the figure. It is exactly similar to that of the preceding ring; and is crossed in the same manner by the muscle from the opposite side of the ring.

Throughout the eight following rings, the muscle f which runs through them all is very broad and strong. The anterior part of it is fixed at the intermediate inferior line, on the fold of the first division of the ring: the other part is fixed beyond the lower division; with this difference, that at the 10th and 11th rings it is fixed at the last fold of its ring; whereas, in the others it passes over that ring, and is inserted into the skin of the following one. In all these,

Microscope these, the first extremity of the muscle *g* is fastened to the fold which separates the ring from the preceding one, and is parallel to *f*, and placed at the side of it. The six first muscles marked *g*, are forked; that of the fourth ring being more so than the rest, nor does it unite till near its anterior insertion. The longest tail lays hold of the following, and is inserted near the inferior line; the other inserts itself near the same line, at about the middle of its own ring. The two last do not branch out; but terminate at the divisions, without reaching the following ring. The muscle *b*, placed at the side of *f*, has nearly the same direction, and finishes at the folds of the ring.

The anterior part of the 12th ring has only one gastric muscle, marked *e*: it is placed on the intermediate inferior line; and is inserted at the folds of the upper division, and at the subdivision of this ring. The lower part has a larger muscle marked *c*, with several divisions; one placed under *b*, with one extremity fixed near the lateral line, at the subdivision of its ring; the other to the fecal bag, a little lower than the muscle *b*.

In fig. 51. all the gastric muscles described in fig. 50. disappear, as well as those lateral and dorsal ones of which the letters are not to be found in this figure.

In the first ring are the gastric muscles, *a*, *f*, *g*, which are best seen here: the first is narrow and long, passing under and crossing *f*: one of its insertions is at the lower line, the other at the lateral, between the spiraculum and neck: *f* is short, broad, and nearly straight, placed along the intermediate line; but between it and the lateral it passes under *e*, and is fixed to the fold of the skin which goes from the one bag to the other; the lower insertion is near the second division. There are sometimes three muscles of those marked *g*, and sometimes four: the lower parts of them are fixed about the middle of the ring, and the anterior parts at the fold of the skin near the neck. The muscles *i* and *h* are fixed to the same fold; the other end of *h* being fixed under the muscle *u*, near the spiraculum. Above the upper end of *f*, a muscular body, *g*, may be seen. It is formed by the separation of two floating muscles.

The second ring has six gastric muscles, *k*, *l*, *m*, *n*, *o*, *p*. The first is a large oblique muscle, with three or four divisions placed at the anterior part of the ring: the head is fixed between the inferior line and its intermediate one, at the fold of the second division; from whence it crosses the inferior line and its corresponding muscle, terminating to the right and left of the line. *i* is a narrow muscle, whose head is fixed to the fold of the second division; the tail of it lying under *n*, and fastened to the edge of the skin that forms the cavity for the leg. The two muscles marked *m* have the same obliquity, and are placed the one on the other: the head is inserted in the skin under the muscle *h*, and communicates by a number of fibres with the tail of the muscle *r*; the other end is fixed to the intermediate inferior line at the fold of the third division. The large and broad muscle *n*, covers the lower edge of the cavity of the limb, and the extremity of the tail of *l*. It is fixed first at the skin, near the intermediate line, from whence it goes

in a perpendicular direction towards *m*, and introduces **Microscope** itself under *o* and *m*, where it is fixed. The muscle *o* is narrow and bent, and covers the edge of the cavity of the leg for a little way; one end terminating there, and the other finishing at the third division near *m*. That marked *p* is also bent: it runs near the anterior edge of the cavity of the leg; one end meets the head of *o*, the other end terminates at a raised fold near the inferior line. There is a triangular muscle on the side of the lateral muscle *o*, similar to that marked *g* in the following ring: in this figure it is entirely concealed by the muscle *m*.

The third ring has no muscle similar to *m*; that marked *k* differs only from that of the second ring in being crossed by the opposite muscle. Those marked *l*, *n*, *o*, *p*, are similar to those of the preceding one. The muscle *q* is triangular; the base is fastened to the last fold of the ring; on the lower side it is fixed to the muscle *o*, the top to the skin at the edge of the cavity for the leg.

The eight following rings have the gastric muscles, *i*, *k*, *l*, and *m*. The muscle *i* is quite straight, and placed at some distance from the inferior line: it is broad at the fourth ring, but diminishes gradually in breadth to the 11th. In the fourth it is united; but divides into two heads, which divaricate in the following rings. In the six next rings these heads are fixed nearly at the same place with *a* and *f*; and in the other two it terminates at the fold of the ring. The anterior insertion of the first and last is at the fold where the ring begins: that of the six others is somewhat lower under the place where the muscle *i* terminates. The lower part of the oblique muscle *k* is inserted in the skin near *i*; the upper part at the intermediate inferior muscle upon the fold which separates the following ring, but is wanting in the 11th. The muscle *l* is large, and co-operates with *M*: in the opening and shutting the spiraculum, one of its fixtures is near the intermediate inferior line, at about the same height as *i*. The tail terminates a little below the spiraculum.

The twelfth ring has only the single gastric muscle *d*, which is a bundle of six, seven, or eight muscles: the first fixture of these is at the subdivision of the ring near the inferior line: one or two cross this, and at the same time the similar muscles of the opposite side. Their fixture is at the bottom of the foot; and their office is to assist the muscle *a* in bringing back the foot, and to loosen the claw from what it lays hold of. One of the insertions of this muscle *a* is observed in this figure near *d*, the other near the subdivision of the ring.

Fig. 52. and 53. show the organization of the head of the cossus, though in a very imperfect manner, as M. Lyonet found it necessary to employ twenty figures to explain it fully. The head is represented as it appears when separated from the fat, and disengaged from the neck. HH are the two palpi. The truncated muscles D belong to the lower lip, and assist in moving it. K shows the two ganglions of the neck united. II are the two vessels which assist in spinning the silk. L, the œsophagus. M, the two dissolving vessels. The Hebrew characters יבבב show the continuation of the four cephalic arteries. In fig. 52. the ten abductor muscles of the jaw

Microscope are represented by SS, TT, VV, and Z. Four occipital muscles are seen in fig. 53. under *ee* and *ff*. At *a k* is represented a nerve of the first pair belonging to the ganglion of the neck; *b* is a branch of this nerve.

Fig. 54. exhibits the nerves as seen from the under part; but excepting in two or three nerves, which may be easily distinguished, only one of each pair is drawn, in order to avoid confusion. The nerves of the first ganglion of the neck are marked by capital letters, those of the ganglion (*a*) of the head by Roman letters; the nerves of the small ganglion by Greek characters. Those of the frontal ganglion, except one, by numbers.

The muscles of the *coffus* have neither the colour nor form of those of larger animals. In their natural state they are soft, and of the consistence of a jelly. Their colour is a greyish blue, which, with the silver-coloured appearance of the pulmonary vessels, form a glorious spectacle. After the caterpillar has been soaked for some time in spirit of wine, they lose their elasticity and transparency, becoming firm, opaque, and white, and the air-vessels totally disappear. The number of muscles in a caterpillar is very great. The greatest part of the head is composed of them, and there is a vast number about the *oesophagus*, intestines, &c. the skin is, as it were, lined by different beds of them, placed the one under the other, and ranged with great symmetry. M. Lyonet has been able to distinguish 228 in the head, 1647 in the body, and 2066 in the intestinal tube, making in all 4041.

At first sight the muscles might be taken for tendons, as being of the same colour, and having nearly the same lustre. They are generally flat, and of an equal size throughout; the middle seldom differing either in colour or size from either of the extremities. If they are separated, however, by means of very fine needles, in a drop of some fluid, we find them composed not only of fibres, membranes, and air-vessels, but likewise of nerves; and, from the drops of oil that may be seen floating on the fluid, they appear also to be furnished with many unctuous particles. Their ends are fixed to the skin, but the rest of the muscle is generally free and floating. Several of them branch out considerably; and the branches sometimes extend so far, that it is not easy to discover whether they are distinct and separate muscles or parts of another. They are moderately strong; and those which have been soaked in spirit of wine, when examined by the microscope, are found to be covered with a membrane which may be separated from them; and they appear then to consist of several parallel bands lying longitudinally along the muscle, which, when divided by means of fine needles, appear to be composed of still smaller bundles of fibres lying in the same direction; which, when examined by a powerful magnifier, and in a favourable light, appear twisted like a small cord. The muscular fibres of the spider, which are much larger than those of the caterpillar, consist of two different substances, one soft and the other hard; the latter being twisted round the former spirally, and thus giving it the twisted appearance just mentioned.

There is nothing in the caterpillar similar to the brain in man. We find indeed in the head of this

Microscope insect a part from which all the nerves seem to proceed; but this part is entirely unprotected, and so small, that it does not occupy one fifth part of the head: the surface is smooth, and has neither lobes nor any anfractuosity like the human brain. But if we call this a brain in the caterpillar, we must say that it has *thirteen*: for there are twelve other such parts following each other in a straight line, all of them of the same substance with that in the head, and nearly of the same size; and from them, as well as from that in the head, the nerves are distributed thro' the body.

The spinal marrow in the *coffus* goes along the belly; is very small, forking out at intervals, nearly of the same thickness throughout, except at the ganglions, and is not inclosed in any case. It is by no means so tender as in man; but has a great degree of tenacity, and does not break without a considerable degree of tension. The substance of the ganglions differs from that of the spinal marrow, as no vessels can be discovered in the latter; but the former are full of very delicate ones. There are 94 principal nerves, which divide into innumerable ramifications.

The *coffus* has two large tracheal arteries, creeping under the skin close to the spiracula; one at the right and the other at the left side of the insect, each of them communicating with the air by means of nine spiracula. They are nearly as long as the whole caterpillar; beginning at the first spiraculum, and extending somewhat farther than the last; some branches also extending quite to the extremity of the body. Round each spiraculum the trachea pushes forth a great number of branches, which are again divided into smaller ones, and these further subdivide and spread through the whole body of the caterpillar. The tracheal artery, with all its numerous ramifications, are open elastic vessels, which may be pressed close together, or drawn out considerably, but return immediately to their usual size when the tension ceases. They are naturally of a silver colour, and make a beautiful appearance. This vessel, with its principal branches, is composed of three coats, which may be separated from one another. The outmost is a thick membrane furnished with a great variety of fibres, which describe a vast number of circles round it, communicating with each other by numerous shoots. The second is very thin and transparent, without any particular vessel being distinguishable in it. The third is composed of scaly threads, generally of a spiral form; and so near each other as scarcely to leave any interval. They are curiously united with the membrane which occupies the intervals; and form a tube which is always open, notwithstanding the flexure of the vessel. There are also many other peculiarities in its structure. The principal tracheal vessels divide into 1326 different branches.

The heart of the *coffus* is very different from that of larger animals, being almost as long as the animal itself. It lies immediately under the skin at the top of the back, entering the head, and terminating near the mouth. Towards the last rings of the body it is large and capacious, diminishing very much as it approaches the head, from the fourth to the twelfth division. On both sides, at each division, it has an appendage, which partly

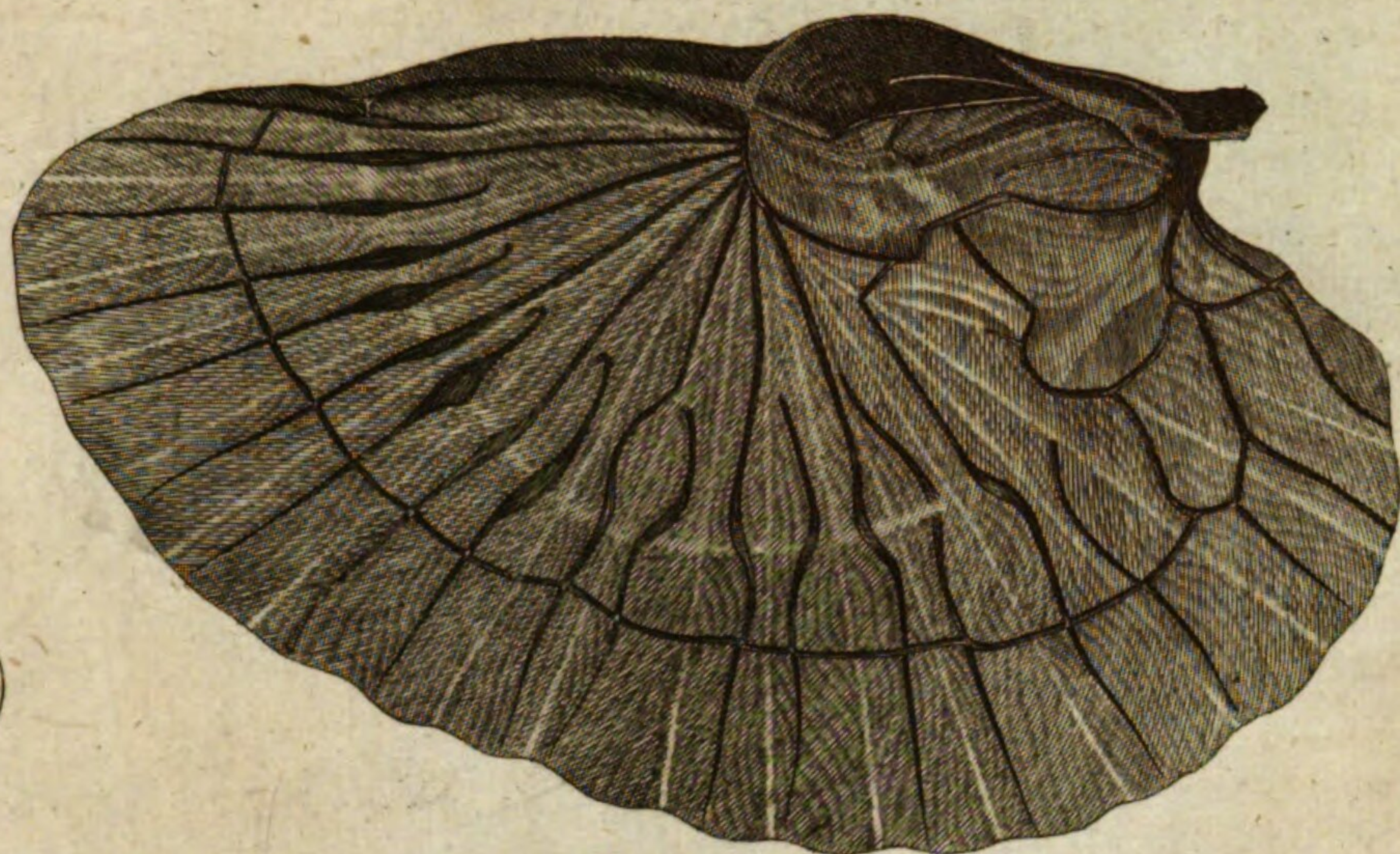


Fig. 57.

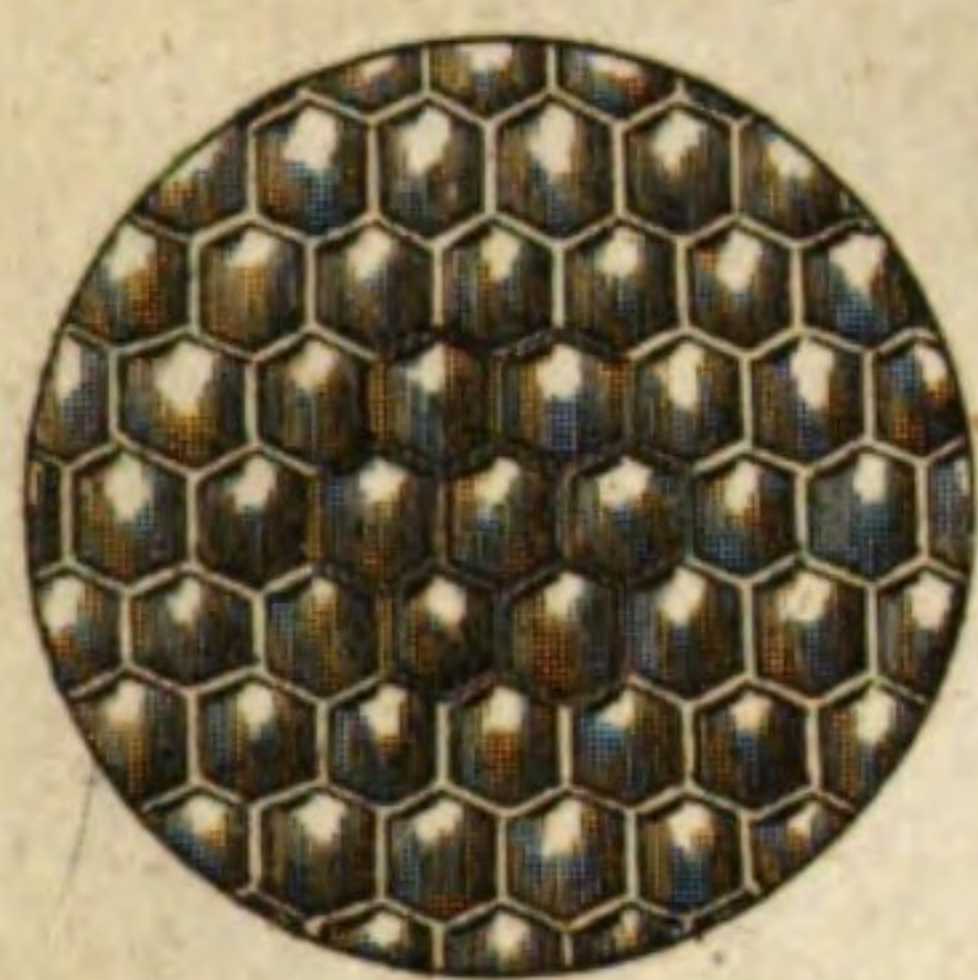


Fig. 59.



Fig. 58.

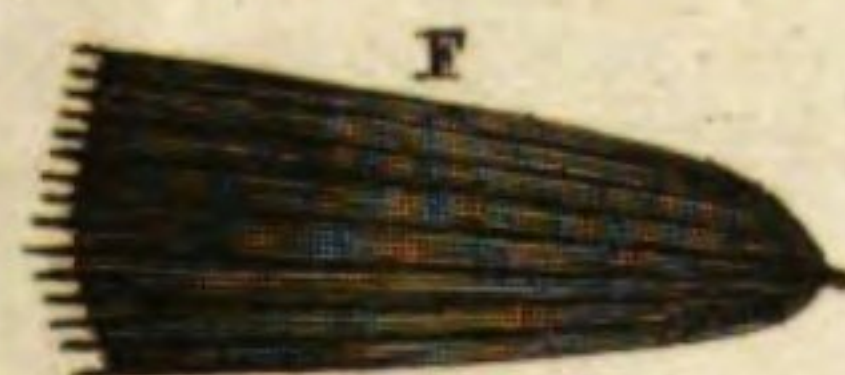
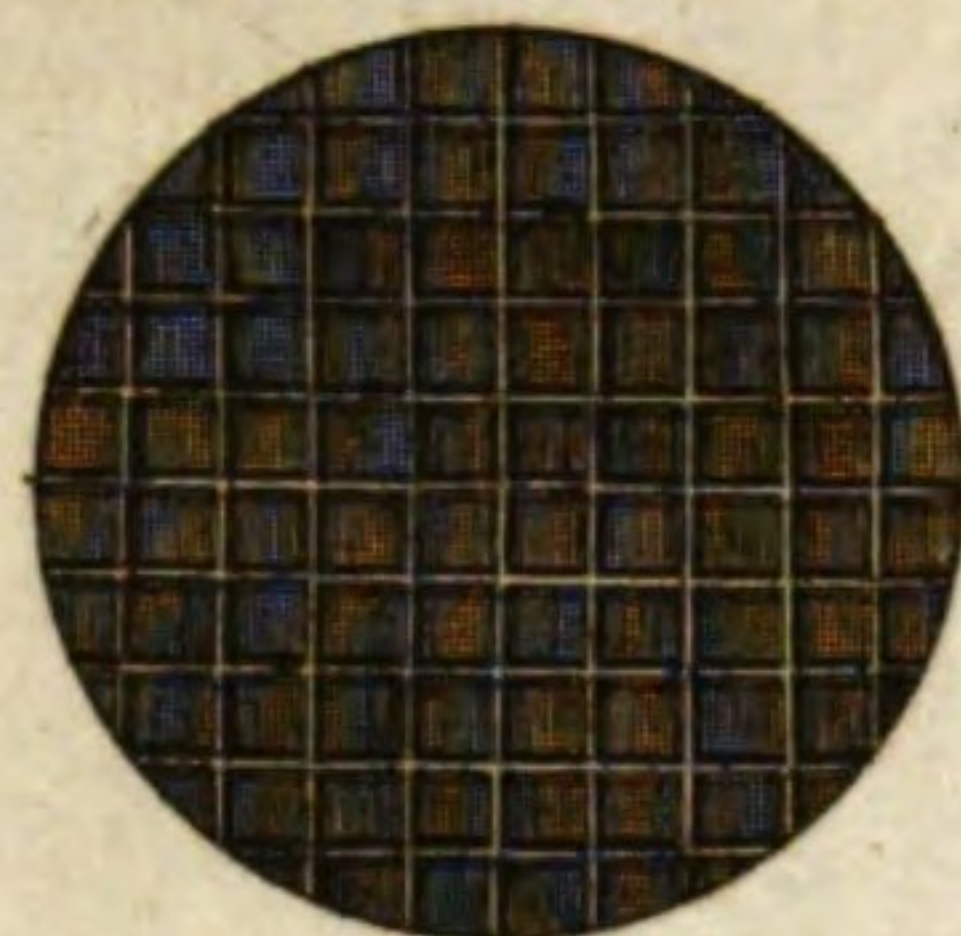
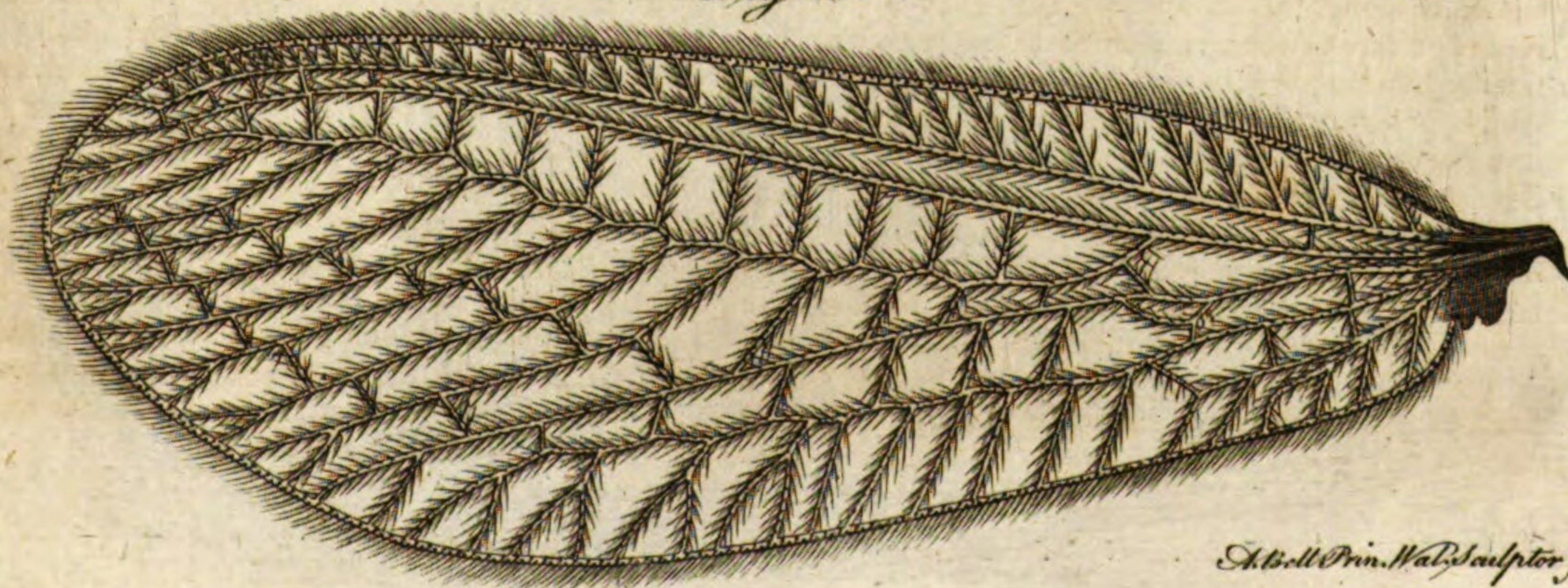
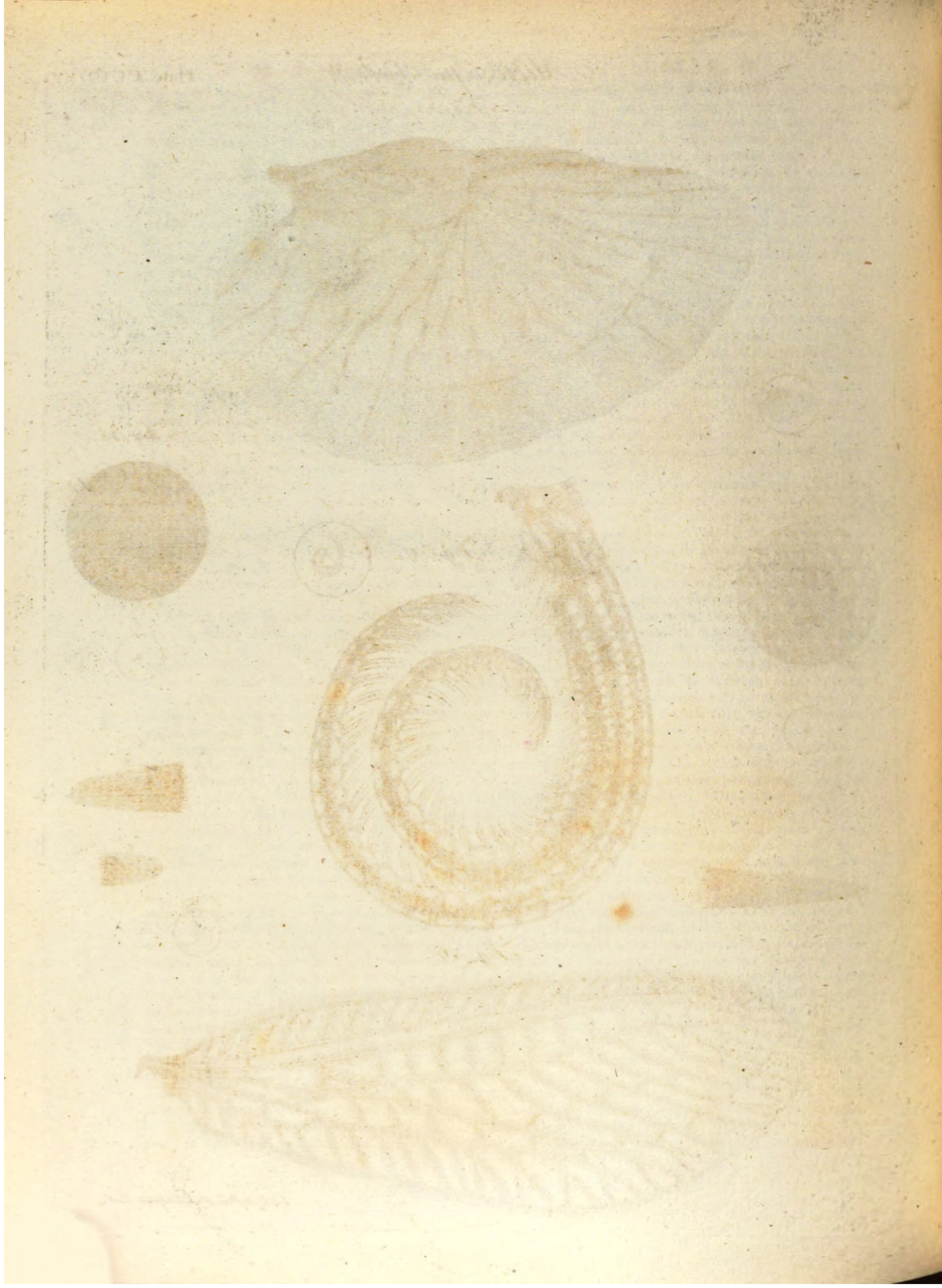
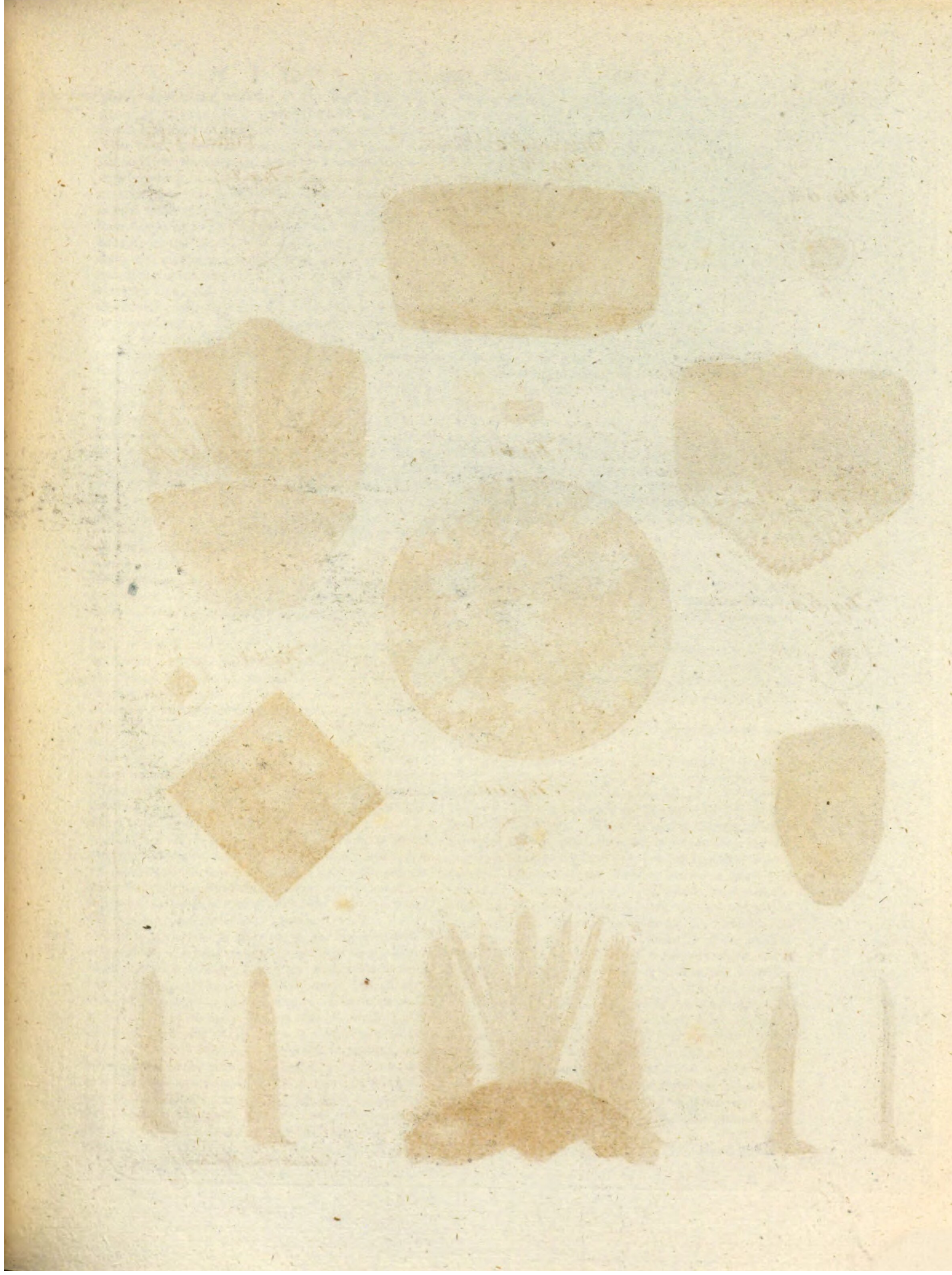


Fig. 56.







Microscopic Objects.
Fig. 65.

Plate CCCV.

Fig. 62.

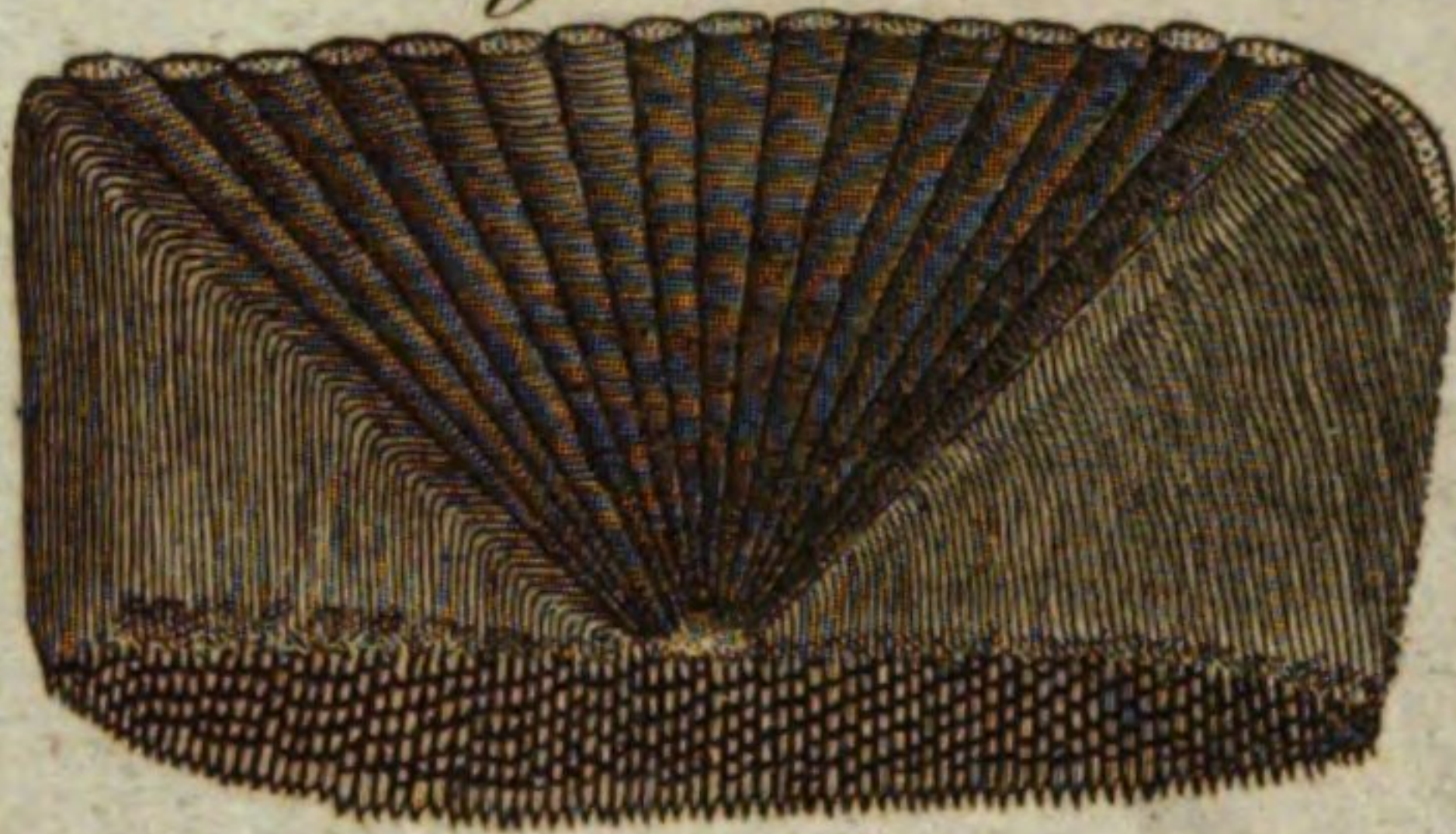


Fig. 64.

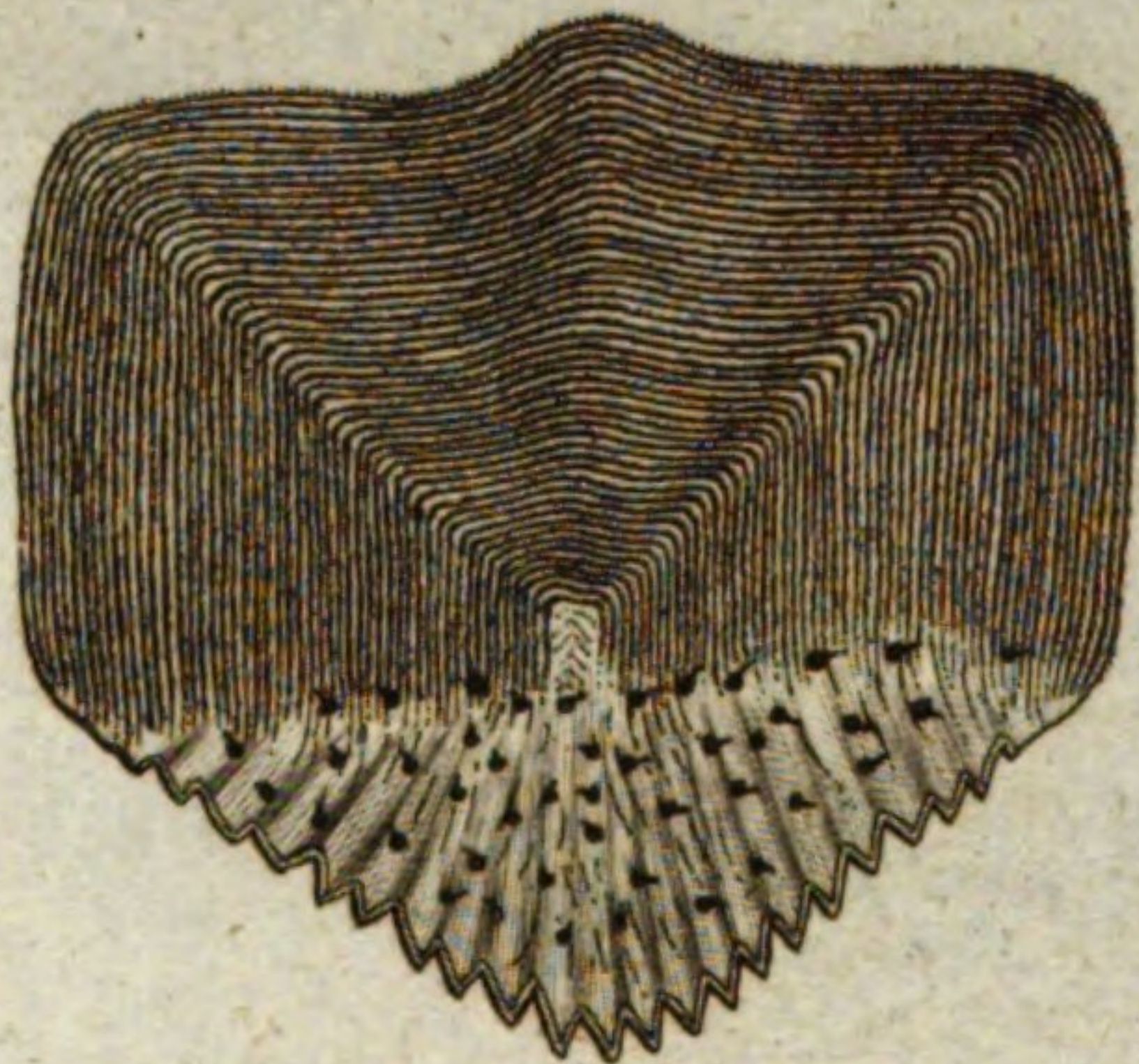


Fig. 61.

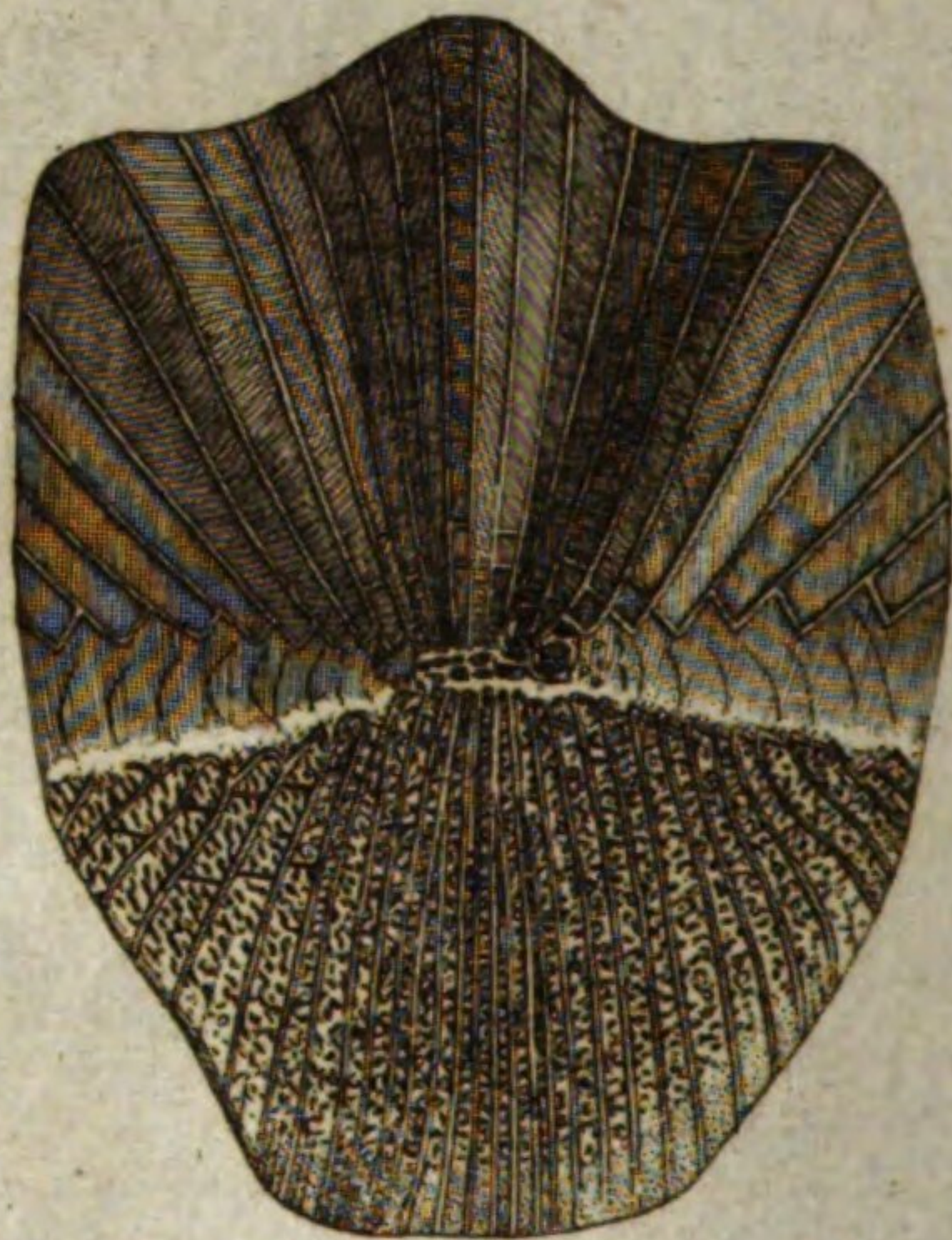


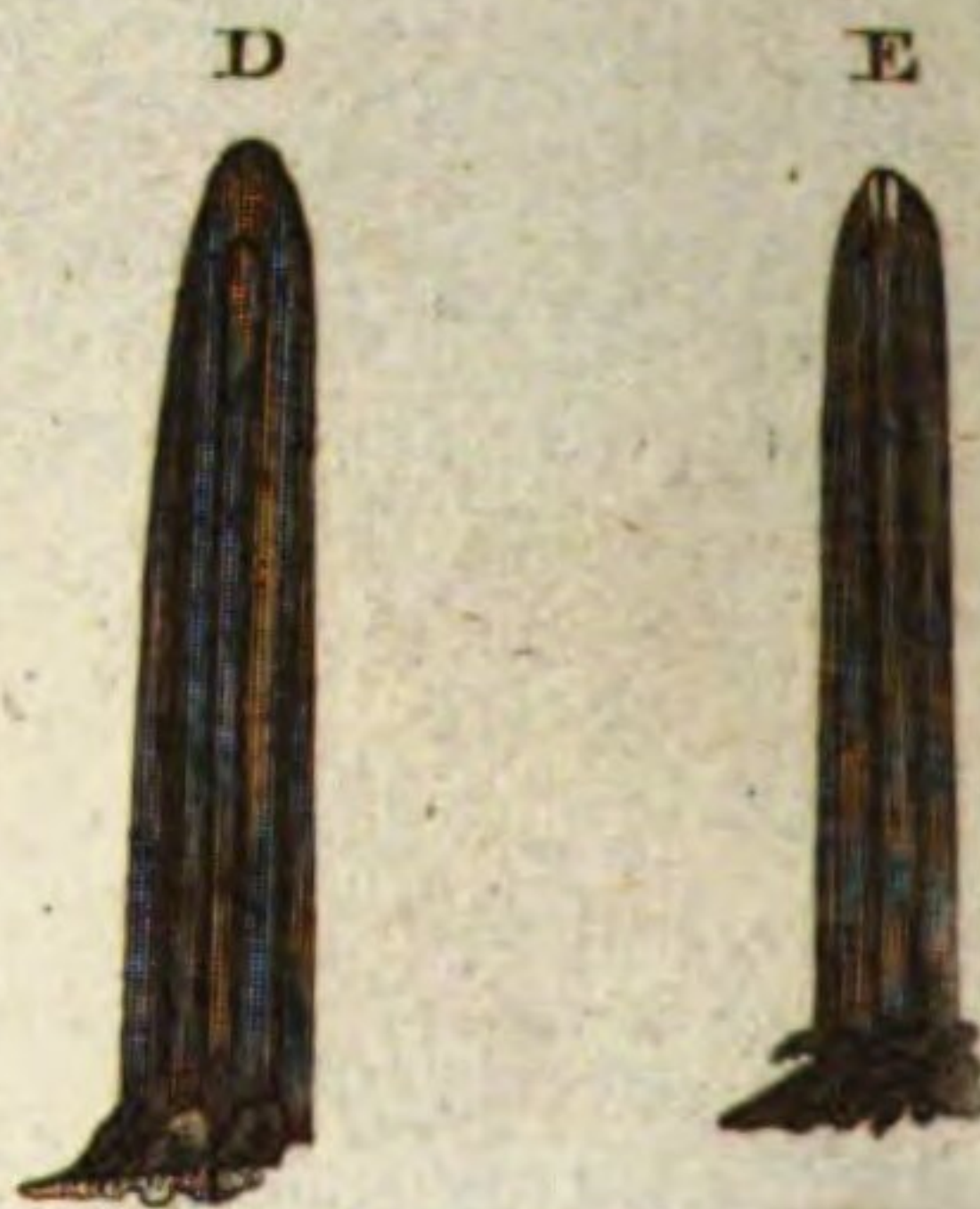
Fig. 63.



Fig. 66.



Fig. 60.



A. Bell. Pin. Wal. Sculptor fecit.

Microscope partly covers the muscles of the back, but which, growing narrower as it approaches the lateral line, it forms a number of irregular lozenge-shaped bodies.— This tube, however, seems to perform none of the functions of the heart in larger animals, as we find no vessel opening into it which answers either to the aorta or vena cava. It is called the heart, because it is generally filled with a kind of lymph, which naturalists have supposed to be the blood of the caterpillar; and because in all caterpillars which have a transparent skin, we may perceive alternate regular contractions and dilatations along the superior line, beginning at the eleventh ring, and proceeding from ring to ring, from the fourth; whence this vessel is thought to be a string or row of hearts. There are two white oblong bodies which join the heart near the eighth division; and these have been called *reniform* bodies, from their having somewhat of the shape of a kidney.

The most considerable part of the whole caterpillar with regard to bulk is the corpus crassum. It is the first and only substance that is seen on opening it. It forms a kind of sheath which envelopes and covers all the entrails, and, introducing itself into the head, enters all the muscles of the body, filling the greatest part of the empty spaces in the caterpillar. It very much resembles the configuration of the human brain, and is of a milk-white colour.

The oesophagus descends from the bottom of the mouth to about the fourth division. The fore-part, which is in the head, is fleshy, narrow, and fixed by different muscles to the crustaceous parts of it; the lower part, which passes into the body, is wider, and forms a kind of membranaceous bag, covered with very small muscles; near the stomach it is narrower, and, as it were, confined by a strong nerve fixed to it at distant intervals. The ventricle begins a little above the fourth division, where the oesophagus ends, and finishes at the tenth. It is about seven times as long as broad; and the anterior part, which is broadest, is generally folded. These folds diminish with the bulk as it approaches the intestines; the surface is covered with a great number of aerial vessels, and opens into a tube, which M. Lyonet calls the large intestine.— There are three of these large tubes, each of which differs so much from the rest, as to require a particular name to distinguish it from them.

The two vessels from which the cossus spins its silk are often above three inches long, and are distinguished into three parts; the anterior, intermediate, and posterior. It has likewise two other vessels, which are supposed to prepare and contain the liquor for dissolving the wood on which it feeds.

Plate CCCIV. Fig. 55. shews the wing of an earwig magnified; *a* represents it of the natural size. The wings of this insect are so artificially folded up under short cases, that few people imagine they have any. Indeed, they very rarely make use of their wings. The cases under which they are concealed are not more than a sixth part of the size of one wing, though a small part of the wing may be discovered, on a careful inspection, projecting from under them. The upper part of the wing is crustaceous and opaque, but the under part is beautifully transparent. In putting up their wings, they first fold back the parts AB, and then shut up the ribs like a fan; the strong muscles used for this purpose being seen at the upper part of the figure. Some of

the ribs are extended from the centre to the outer edge; others only from the edge about half way: but they are all united by a kind of band, at a small but equal distance from the edge; the whole evidently contrived to strengthen the wing, and facilitate its various motions. The insect itself differs very little in appearance in its three different states. De Geer asserts, that the female hatches eggs like a hen, and broods over her young ones as a hen does.

Fig. 56. represents a wing of the *Hemerobius perla* magnified. It is an insect which seldom lives more than two or three days.—The wings are nearly of a length, and exactly similar to one another. They are composed of fine delicate nerves, regularly and elegantly disposed as in the figure, beautifully adorned with hairs, and lightly tinged with green. The body is of a fine green colour; and its eyes appear like two burnished beads of gold, whence it has obtained the name of *golden eye*. This insect lays its eggs on the leaves of the plum or the rose tree; the eggs are of a white colour, and each of them fixed to a little pedicle or foot-stalk, by which means they stand off a little from the leaf, appearing like the fructification of some of the mosses. The larva proceeding from these eggs resembles that of the coccinella or lady-cow, but is much more handsome. Like that, it feeds upon aphides or pucerons, sucking their blood, and forming itself a case with their dried bodies; in which it changes into the pupa state, from whence they afterwards emerge in the form of a fly.

Fig. E, F, I, represent the dust of a moth's wing magnified. This is of different figures in different moths. The natural size of these small plumes is represented at H.

Fig. 57. shows a part of the cornea of the libellula magnified. In some positions of the light, the sides of the hexagons appear of a fine gold colour, and divided by three parallel lines. The natural size of the part magnified is shown at *b*.

Fig. 58. shows the part *c* of a lobster's cornea magnified.

Fig. 59. shows one of the arms or horns of the *lepas antifer*, or barnacle, magnified; its natural size being represented at *d*. Each horn consists of several joints, and each joint is furnished on the concave side of the arm with long hairs. When viewed in the microscope, the arms appear rather opaque; but they may be rendered transparent, and become a most beautiful object, by extracting out of the interior cavity a bundle of longitudinal fibres, which runs the whole length of the arm. Mr Needham thinks that the motion and use of these arms may illustrate the nature of the rotatory motion in the wheel-animal. In the midst of the arms is an hollow trunk, consisting of a jointed hairy tube, which incloses a long round tongue that can be pushed occasionally out of the tube or sheath, and retracted occasionally. The mouth of the animal consists of six laminæ, which go off with a bend, indented like a saw on the convex edge, and by their circular disposition are so ranged, that the teeth, in the alternate elevation and depression of each plate, act against whatever comes between them. The plates are placed together in such a manner, that to the naked eye they form an aperture not much unlike the mouth of a contracted purse.

Fig. 60. shows the apparatus of the *Tabanus* or Gad-fly,

Plate CCCV.

Microscope fly, by which it pierces the skin of horses and oxen, in order to suck their blood. The whole is contained in a fleshy case, not expressed in the figure. The feelers *aa* are of a spongy texture and grey colour, covered with short hairs. They are united to the head by a small joint of the same substance. They defend the other parts of the apparatus, being laid upon it side by side whenever the animal stings, and thus preserve it from external injury. The wound is made by the two lancets *bb* and *B*, which are of a delicate structure, but very sharp, formed like the dissecting knife of an anatomist, growing gradually thicker to the back.—The two instruments *cc* and *C*, appear as if intended to enlarge the wound, by irritating the parts round it; for which they are jagged or toothed. They may also serve, from their hard and horny texture, to defend the tube *e* *E*, which is of a softer nature, and tubular, to admit the blood, and convey it to the stomach. This part is totally inclosed in a line *d* *D*, which entirely covers it. These parts are drawn separately at *B*, *C*, *D*, *E*. De Geer observes, that only the females suck the blood of animals; and Reaumur informs us, that having made one, that had sucked its fill, disgorge itself, the blood it threw up appeared to him to be more than the whole body of the insect could have contained. The natural size of this apparatus is shown at *f*.

Fig. 61. shows a bit of the skin of a lump-fish (*Cyclopterus*) magnified. When a good specimen of this can be procured, it forms a most beautiful object. The tubercles exhibited in the figure probably secrete an unctuous juice.

Fig. 62. shows the scale of a sea-perch found on the English coast; the natural size is exhibited at *b*.

Fig. 63. is the scale of an haddock magnified; its natural size as within the circle.

Fig. 64. the scale of a parrot fish from the West Indies magnified; *l* the natural size of it.

Fig. 65. the scale of a kind of perch in the West Indies magnified; *k* the natural size of the scale.

Fig. 66. part of the skin of a sole fish, as viewed through an opaque microscope; the magnified part, in its real size, shown at *l*.

The scales of fishes afford a great variety of beautiful objects for the microscope. Some are long; others round, square, &c. varying considerably not only in different fishes, but even in different parts of the same fish. Leeuwenhoek supposed them to consist of an infinite number of small scales or strata, of which those next to the body of the fish are the largest. When viewed by the microscope, we find some of them ornamented with a prodigious number of concentric flutings, too near each other, and too fine to be easily enumerated. These flutings are frequently traversed by others diverging from the centre of the scale, and generally proceeding from thence in a straight line to the circumference.

For a more full information concerning these and other microscopical objects, the reader may consult Mr Adams's *Essays on the Microscope*, who has made the most valuable collection that has yet appeared on the subject. See also the articles ANIMALCULE, CRYSTALLIZATION, POLYPE, PLANTS, and WOOD, in the present Work.

MIDAS (fab. hist.), a famous king of Phrygia, who having received Bacchus with great magnificence,

that god, out of gratitude, offered to grant him whatever he should ask. Midas desired that every thing he touched should be changed into gold. Bacchus consented; and Midas, with extreme pleasure, everywhere found the effects of his touch. But he had soon reason to repent of his folly: for wanting to eat and drink, the aliments no sooner entered his mouth than they were changed into gold. This obliged him to have recourse to Bacchus again, to beseech him to restore him to his former state; on which the god ordered him to bathe in the river Pactolus, which from thence forward had golden sands. Some time after, being chosen judge between Pan and Apollo, he gave another instance of his folly and bad taste, in preferring Pan's music to Apollo's; on which the latter being enraged, gave him a pair of asses ears. This Midas attempted to conceal from the knowledge of his subjects: but one of his servants saw the length of his ears, and being unable to keep the secret, yet afraid to reveal it from apprehension of the king's resentment, he opened a hole in the earth, and after he had whispered there that Midas had the ears of an ass, he covered the place as before, as if he had buried his words in the ground. On that place, as the poets mention, grew a number of reeds, which when agitated by the wind uttered the same sound that had been buried beneath, and published to the world that Midas had the ears of an ass. Some explain the fable of the ears of Midas, by the supposition that he kept a number of informers and spies, who were continually employed in gathering every seditious word that might drop from the mouths of his subjects. Midas, according to Strabo, died of drinking bull's hot blood. This he did, as Plutarch mentions, to free himself from the numerous ill dreams which continually tormented him. Midas, according to some, was son of Cybele. He built a town which he called *Ancyra*.

MIDAS, *Ear-shell*, the smooth ovato-oblong buccinum, with an oblong and very narrow mouth. It consists of six volutions, but the lower one alone makes up almost the whole shell.

MID-HEAVEN, the point of the ecliptic that culminates, or in which it cuts the meridian.

MIDDLEBURG, one of the Friendly Islands in the South Sea. This island was first discovered by Tasman, a Dutch navigator, in January 1742-3; and is called by the natives *Ea-Oo-ube*: it is about 16 miles from north to south, and in the widest part about 8 miles from east to west. The skirts are chiefly laid out in plantations, the south-west and north-west sides especially. The interior parts are but little cultivated, though very capable of it: but this neglect adds greatly to the beauty of the island; for here are agreeably dispersed groves of cocoa-nuts and other trees, lawns covered with thick grass, here and there plantations and paths leading to every part of the island, in such beautiful disorder, as greatly to enliven the prospect. The hills are low; the air is delightful; but unfortunately water is denied to this charming spot. Yams, with other roots, bananas, and bread-fruit, are the principle articles of food; but the latter appeared to be scarce. Here is the pepper-tree, or *ava-ava*, with which they make an intoxicating liquor, in the same disgusting manner as is practised in the Society Islands. Here are several odoriferous trees and shrubs,

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particularly a species of the lemon tribe; and the botanical gentlemen met with various new species of plants. Here also are a few hogs and fowls.

There are no towns or villages; most of the houses are built in plantations, which are laid out in different parts, with no other order than what convenience requires. They are neatly constructed, but are less roomy and convenient than those in the Society Isles. The floors are a little raised, and covered with thick strong mats. The same sort of matting serves to inclose them on the windward side, the others being open. They have little areas before most of them, which are planted round with trees or ornamental shrubs, whose fragrance perfumes the air. Their household furniture consists of a few wooden platters, cocoa-nut shells, and pillows made of wood, and shaped like four-footed stools or forms: their common clothing, with the addition of a mat, serves them for bedding.

The natives are of a clear mahogany or chestnut brown, with black hair, in short frizzled curls, which seems to be burnt at the tips; their beards are cut or shaven. The general stature of the men is equal to our middle size, from five feet three to five feet ten inches; the proportions of the body are very fine, and the *contours* of the limbs extremely elegant, though something more muscular than at Otaheite, which may be owing to a greater and more constant exertion of strength in their agriculture and domestic economy. Their features are extremely mild and pleasing; and differ from the old Otaheitian faces in being more oblong than round, the nose sharper, and the lips rather thinner. The women are, in general, a few inches shorter than the men, but not so small as the lower class of women at the Society Islands. The practice of puncturing the skin, and blacking it, which is called *tattooing*, is in full force among the men here, for their belly and loins are very strongly marked in configurations more compounded than those at Otaheite. The tenderest parts of the body were not free from these punctures; the application of which, besides being very painful, must be extremely dangerous on glandulous extremities.

The men in general go almost naked, having only a small piece of cloth round the loins, but some wrapt it in great abundance round them from their waist: this cloth is manufactured much like that at Otaheite, but overspread with a strong glue, which makes it stiff, and fit to resist the wet. The women are likewise covered from the waist downwards: they often have loose necklaces, consisting of several strings of small shells, seeds, teeth of fishes; and in the middle of all, the round *operculum*, or cover of a shell as large as a crown-piece. The men frequently wear a string round their necks, from which a mother-of-pearl shell hangs down on the breast; both the ears of the women were perforated with two holes, and a cylinder cut out of tortoise-shell or bone was struck through both the holes. The most remarkable circumstance observed of this people was, that most of them wanted the little finger on one, and sometimes on both hands: the difference of sex or age did not exempt them from this amputation; for even among the few children that were seen running about naked, the greater part had already suffered such loss. This circumstance was observed by Tasman. Another singularity which was observed to be very general among these people, was

a round spot on each cheek-bone, which appeared to have been burnt or blistered. On some it seemed to have been recently made, on others it was covered with scurf, and many had only a slight mark of its former existence: how, or for what purpose it was made, could not be learnt. The women here, in general, were reserved; and turned, with disgust, from the immodest behaviour of ungovernable seamen: there were not, however, wanting some who appeared to be of easy virtue, and invited their lovers with lascivious gestures. The language spoken here is soft, and not unpleasing; and whatever they said was spoken in a kind of singing tone. Omai and Mahine, who were both passengers on board the ship, at first declared that the language was totally new and unintelligible to them; however, the affinity of several words being pointed out, they soon caught the particular modification of this dialect, and conversed much better with the natives than any on board the ships could have done, after a long intercourse. They have the neatest ornaments imaginable, consisting of a number of little flat sticks, about five inches long, of a yellow wood like box, firmly and elegantly connected together at the bottom by a tissue of the fibres of cocoa-nut, some of which were of their natural colour, and others dyed black; the same fibres were likewise used in the making of baskets, the taste of which was highly elegant, and varied into different forms and patterns. Their clubs are of a great variety of shapes, and many of them so ponderous as scarce to be managed with one hand. The most common form was quadrangular, so as to make a rhomboid at the broad end, and gradually tapering into a round handle at the other. Far the greater part were carved all over in many chequered patterns, which seemed to have required a long space of time, and incredible patience, to work up; as a sharp stone, or a piece of coral, are the only tools made use of: the whole surface of the plain clubs was as highly polished as if an European workman had made them with the best instruments. Besides clubs, they have spears of the same wood, which were sometimes plain sharp-pointed sticks, and sometimes barbed with a sting-ray's tail. They have likewise bows and arrows of a peculiar construction: the bow, which is six feet long, is about the thickness of a little finger, and when slack forms a slight curve; its convex part is channelled with a single deep groove, in which the bow-string is lodged. The arrow is made of reed, near six feet long, and pointed with hard wood: when the bow is to be bent, instead of drawing it so as to increase the natural curvature, they draw it the contrary way, make it perfectly straight, and then form the curve on the other side. Most of their canoes have outriggers, made of poles, and their workmanship is very admirable: two of these canoes are joined together with a surprising exactness, and the whole surface receives a very curious polish. Their paddles have short broad blades, something like those at Otaheite, but more neatly wrought and of better wood.

They keep their dead above ground, after the manner of the Society Islands; as a corpse was seen deposited on a low hut.

Here were seen several men and women afflicted with leprous diseases, in some of whom the disorder had risen to a high degree of virulence: one man in

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particular had his back and shoulders covered with a large cancerous ulcer, which was perfectly livid within, and of a bright yellow all round the edges. A woman was likewise unfortunate enough to have her face destroyed by it in the most shocking manner; there was only a hole left in the place of her nose; her cheek was swelled up, and continually oozing out a purulent matter; and her eyes seemed ready to fall out of her head, being bloody and sore: though these were some of the most miserable objects that could possibly be seen, yet they seemed to be quite unconcerned about their misfortunes, and traded as briskly as any of the rest.

MIDDLELAM, a town in the north-riding of Yorkshire, situated on the river Ure, 255 miles from London. It had once a castle, where was born Edward prince of Wales, only son of Richard III.; and is noted for a woollen manufactory and frequent horse-races. Its market is on Monday; and fairs Nov. 6. and 7. The town stands on a rising ground; and the castle, which was on the south side, was formerly moated round by the help of a spring conveyed in pipes from the higher grounds. The church of Middlelam is extra-parochial.

MIDDLESEX, a county of England, which derives its name from its situation amidst the three kingdoms of the East, West, and South Saxons. It is bounded on the north by Hertfordshire; on the south by the river Thames, which divides it from Surry; on the west by the river Colne, which separates it from Buckinghamshire; and on the east by the river Lea, which divides it from Essex. It extends about 23 miles in length, but hardly 14 in breadth, and is not more than 115 in circumference; but as it comprehends the two vast cities of London and Westminster, which are situated in the south-east part of the county, it is by far the wealthiest and most populous county in England. It is divided into 602 liberties, containing 200 parishes, besides a vast number of chapels of ease, and 5 market-towns, exclusive of the cities of London and Westminster. The air is very pleasant and healthy, to which a fine gravelly soil does not a little contribute. The soil produces plenty of corn, and the county abounds with fertile meadows and gardeners grounds. In a word, the greater part of the county is so prodigiously assisted by the rich compost from London, that the whole of the cultivated part may be considered as a garden. The natural productions are cattle, corn, and fruit; but its manufactures are too many to be enumerated here, there being hardly a single manufacture practised in Great Britain but what is also established in this county.—Though London is the chief city, Brentford is the county-town where the members of parliament are elected.

MIDDLETON (Dr Conyers), a very celebrated English divine, the son of a clergyman in Yorkshire, was born at Richmond in 1683. He distinguished himself, while fellow of Trinity-college, Cambridge, by his controversy with Dr Bentley his master, relating to some mercenary conduct of the latter in that station. He afterwards had a controversy with the whole body of physicians, on the dignity of the medical profession; concerning which he published *De medicorum apud veteres Romanos degentium conditione dissertatio; qua, contra viros celeberrimos Jacobum Sponium et Richardum Meadium, servilem atque ignobilem eam fuisse,*

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ostenditur: and in the course of this dispute much resentment and many pamphlets appeared. Hitherto he had stood well with his clerical brethren; but he drew the resentment of the church on him in 1729, by writing "A letter from Rome, showing an exact conformity between popery and paganism," &c.; as this letter, though politely written, yet attacked Popish miracles with a gaiety that appeared dangerous to the cause of miracles in general. Nor were his Objections to Dr Waterland's manner of vindicating Scripture against Tindal's "Christianity as old as the Creation," looked on in a more favourable point of view. In 1741, came out his great work, "The history of the life of M. Tullius Cicero," 2 vols 4to; which is indeed a fine performance, and will probably be read as long as taste and polite literature subsist among us: the author has nevertheless fallen into the common error of biographers, who often give panegyrics instead of history. In 1748, he published, "A free inquiry into the miraculous powers which are supposed to have subsisted in the Christian church from the earliest ages, through several successive centuries." He was now attacked from all quarters; but before he took any notice of his antagonists, he supplied them with another subject in "An examination of the lord bishop of London's discourses concerning the use and extent of prophecy," &c. Thus Dr Middleton continued to display talents and learning, which were highly esteemed by men of a free turn of mind, but by no means in a method calculated to invite promotion in the clerical line. He was in 1723 chosen principal librarian of the public library at Cambridge; and if he rose not to dignities in the church, he was in easy circumstances, which permitted him to assert a dignity of mind often forgotten in the career of preferment. He died in 1750, at Hilderham in Cambridgeshire, an estate of his own purchasing; and in 1752, all his works, except the life of Cicero, were collected in 4 vols, 4to.

MIDDLEWICH, a town of Cheshire, 167 miles from London. It stands near the conflux of the Croke and Dan, where are two salt-water springs, from which are made great quantities of salt, the brine being said to be so strong as to produce a full fourth part salt. It is an ancient borough, governed by burgesses; and its parish extends into many adjacent townships. It has a spacious church. Its market is on Tuesdays; and fairs on St James's-day, July 25. and Holy-Thurs-day. By the late inland navigation, it has communication with the rivers Mersey, Dee, Ribble, Ouse, Trent, Darwent, Severn, Humber, Thames, Avon, &c. which navigation, including its windings, extends above 500 miles, in the counties of Lincoln, Nottingham, York, Lancaster, Westmoreland, Stafford, Warwick, Leicester, Oxford, Worcester, &c. The river Wheelock, after a course of about 12 miles from Mowcop-hill, runs into the Dan a little above this town.

MIDHURST, a town of Sussex, 52 miles from London, has been represented in parliament ever since the 4th of Edward II. It is a neat small town, on a hill surrounded with others, having the river Arun at the bottom; and is a borough by prescription, governed by a bailiff, chosen annually by a jury at a court-leet of the lord of the manor. The market is on Thursday; fairs on March 21. and the Thursday after.

MIDIAN,

Middleton
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Midhurst.

Midian
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Midship-
man.

MIDIAN, or **MADIAN** (anc. geog.), a town on the south side of Arabia Petræa; so called from one of the sons of Abraham by Keturah.—Another *Midian*, near the Arnon and Æoplis, in ruins in Jerome's time. With the daughters of these Midianites the Israelites committed fornication, and were guilty of idolatry. A branch of the Midianites dwelt on the Arabian gulph, and were called *Kenites*; some of whom turned proselytes, and dwelt with the Israelites in the land of Canaan.

MID-LOTHIAN. See **LOTHIAN**.

MIDSHIP-FRAME, a name given to that timber, or combination of pieces formed into one timber, which determines the extreme breadth of the ship, as well as the figure and dimension of all the inferior timbers.

In the article *SHIP-BUILDING*, the reader will find a full explanation of what is meant by a frame of timbers. He will also perceive the outlines of all the principal frames, with their gradual dimensions, from the midship-frame delineated in the plane of projection annexed to that article. As the parts of which the several frames are composed have the same relation to each other throughout the vessel, and as all the corresponding pieces, without and within those frames, are also nearly alike, and fixed in the same manner, it will be here sufficient for our purpose to represent the principal or midship-frame, together with its corresponding parts, which are as follow:—A, the keel, with *a* the false keel beneath it. B, the chocks fixed upon the kelson, to retain the opposite pieces of the *riders* firmly together. C, one of the beams of the orlop. D, one of the lower deck beams; with *d* the beams of the upper deck. E, the hanging-knees, by which the beams are attached to the timbers. F, the standards, which are fixed above the decks to which they belong. G, the clamps, which sustain the extremities of the beams. H, the gun-ports of the lower-deck; with *h* the ports of the upper-deck. I, K, L, different pieces of *thick-stuff*, placed opposite to the several scarfs or joinings, in the frame of timbers. M, the planks of the deck. N, the water-ways. O, the planks of the ceiling, between the several ranges of thick-stuff. P, the spirketing. Q, the main-wale, to fortify the ship's side opposite to the lower deck. R, the channel-wale, opposite to the upper deck. S, the waist-rail. T, the string, with the moulding under the gun-wale. U, the floor-timbers, which are laid across the keel and bolted to it. V, the several futtocks; and W the top-timbers, which are all united into one frame. X, the kelson.

MIDSHIPMAN, a sort of naval cadet, appointed by the captain of a ship of war, to second the orders of the superior officers, and assist in the necessary business of the vessel, either aboard or ashore.

The number of midshipmen, like that of several other officers, is always in proportion to the size of the ship to which they belong. Thus a first-rate man of war has 24, and the inferior rates a suitable number in proportion. No person can be appointed lieutenant without having previously served two years in the royal navy in this capacity, or in that of *mate*, besides having been at least four years in actual service at sea, either in merchant-ships or in the royal navy.

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Midshipman is accordingly the station in which a young volunteer is trained in the several exercises necessary to attain a sufficient knowledge of the machinery, movements, and military operations of a ship, to qualify him for a sea-officer.

On his first entrance in a ship of war, every midshipman has several disadvantageous circumstances to encounter. These are partly occasioned by the nature of the sea-service; and partly by the mistaken prejudices of people in general respecting naval discipline, and the genius of sailors and their officers. No character, in their opinion, is more excellent than that of the common sailor, whom they generally suppose to be treated with great severity by his officers, drawing a comparison between them not very advantageous to the latter. The midshipman usually comes aboard tinctured with these prejudices, especially if his education has been amongst the higher rank of people; and if the officers happen to answer his opinion, he conceives an early disgust to the service, from a very partial and incompetent view of its operations. Blinded by these prepossessions, he is thrown off his guard, and very soon surprised to find, amongst those honest sailors, a crew of abandoned miscreants, ripe for any mischief or villany. Perhaps, after a little observation, many of them will appear to him equally destitute of gratitude, shame, or justice, and only deterred from the commission of any crimes by the terror of severe punishment. He will discover, that the pernicious example of a few of the vilest in a ship of war are too often apt to poison the principles of the greatest number, especially if the reins of discipline are too much relaxed, so as to foster that idleness and dissipation, which engender sloth, diseases, and an utter profligacy of manners. If the midshipman on many occasions is obliged to mix with these, particularly in the exercises of extending or reducing the sails in the tops, he ought resolutely to guard against this contagion, with which the morals of his inferiors may be infected. He should, however, avail himself of their knowledge, and acquire their expertness in managing and fixing the sails and rigging, and never suffer himself to be excelled by an inferior. He will probably find a virtue in almost every private sailor, which is entirely unknown to many of his officers: that virtue is emulation, which is not indeed mentioned amongst their qualities by the gentlemen of *terra firma*, by whom their characters are often copiously described with very little judgment. There is hardly a common tar who is not envious of superior skill in his fellows, and jealous on all occasions to be outdone in what he considers as a branch of his duty: nor is he more afraid of the dreadful consequences of whistling in a storm, than of being stigmatised with the opprobrious epithet of *lubber*. Fortified against this scandal, by a thorough knowledge of his business, the sailor will sometimes sneer in private at the execution of orders which to him appear awkward, improper, or unlike a seaman. Nay, he will perhaps be malicious enough to suppress his own judgment, and, by a punctual obedience to command, execute whatever is to be performed in a manner which he knows to be improper, in order to expose the person commanding to disgrace and ridicule. Little skilled in the method of the schools, he considers the

Midship-
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Midship-
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officer who cons his lesson by rote as very ill qualified for his station, because particular situations might render it necessary for the said officer to assist at putting his own orders in practice. An ignorance in this practical knowledge will therefore necessarily be thought an unpardonable deficiency by those who are to follow his directions. Hence the midshipman who associates with these sailors in the tops, till he has acquired a competent skill in the service of extending or reducing the sails, &c. will be often entertained with a number of scurrilous jests, at the expence of his superiors. Hence also he will learn, that a timely application to those exercises can only prevent him from appearing in the same despicable point of view, which must certainly be a cruel mortification to a man of the smallest sensibility.

If the midshipman is not employed in these services, which are undoubtedly necessary to give him a clearer idea of the different parts of his occupation, a variety of other objects present themselves to his attention. Without presuming to dictate the studies which are most essential to his improvement, we could wish to recommend such as are most suitable to the bent of his inclination. Astronomy, geometry, and mechanics, which are in the first rank of science, are the materials which form the skilful pilot and the superior mariner. The theory of navigation is entirely derived from the two former, and all the machinery and movements of a ship are founded upon the latter. The action of the wind upon the sails, and the resistance of the water at the stem, naturally dictate an inquiry into the property of solids and fluids; and the state of the ship, floating on the water, seems to direct his application to the study of hydrostatics, and the effects of gravity. A proficiency in these branches of science

will equally enlarge his views, with regard to the operations of naval war, as directed by the efforts of powder and the knowledge of projectiles. The most effectual method to excite his application to those studies, is, perhaps, by looking round the navy, to observe the characters of individuals. By this inquiry he will probably discover, that the officer who is eminently skilled in the sciences, will command universal respect and approbation; and that whoever is satisfied with the despicable ambition of shining the hero of an assembly, will be the object of universal contempt. The attention of the former will be engaged in those studies which are highly useful to himself in particular, and to the service in general. The employment of the latter is to acquire those superficial accomplishments that unbend the mind from every useful science, emasculate the judgment, and render the hero infinitely more dexterous at falling into his station in the dance than in the line of battle.

Unless the midshipman has an unconquerable aversion to the acquisition of those qualifications which are so essential to his improvement, he will very rarely want opportunities of making a progress therein. Every step he advances in those meritorious employments will facilitate his accession to the next in order. If the dunces, who are his officers or mess-mates, are rattling the dice, roaring bad verses, hissing on the flute, or scraping discord from the fiddle, his attention to more noble studies will sweeten the hours of relaxation. He should recollect, that no example from fools ought to influence his conduct, or seduce him from that laudable ambition which his honour and advantage are equally concerned to pursue.

MIDWIFE, one whose profession is to deliver women in labour. See MIDWIFERY.

Midship-
man.

M I D W I F E R Y,

THE art of assisting women in the birth of children. It is supposed to comprehend also the management of women both before and after delivery, as well as the treatment of the child in its most early state.

HISTORY of Midwifery. The art of midwifery is certainly almost coeval with mankind. The first *midwife* of whom mention is made under that name, assisted at the second labour of Rachel, the wife of Jacob. Another midwife is spoken of in Genesis, at the lying-in of Tamar, who was delivered of twins. But the most honourable mention of midwives is that in Exodus, when Pharaoh king of Egypt, who had a mind to destroy the Hebrews, commanded the midwives to kill all the male children of the Hebrew women; which command they disobeyed, and thereby obtained a recompence from God.

From all the passages in Scripture where midwives are mentioned, it is plain, that women were the only practitioners of this art among the Hebrews. Among the Greeks also women assisted at labours. Phanarete, the mother of Socrates, was a midwife. Plato speaks at large of midwives, explains their functions, regu-

lates their duties, and remarks that they had at Athens the right of proposing or making marriages. Hippocrates makes mention of midwives, as well as Aristotle, Galen, and Aëtius. This last even frequently quotes a woman called *Aspasia*, who was probably a midwife. They were called among the Greeks *Maiai* or *ἰατρομαῖαι*; that is to say, *mamma*, or *grand-mamma*.

We are still better acquainted with the customs of the Romans, and know that they employed women only. This may be deduced from the comedies of Plautus and Terence alone. We there see that they are women only who are called to assist persons in labour. Besides, Pliny, in his *Natural History*, frequently speaks of midwives and their duties; and names two, *Sotira* and *Salpe*, who had apparently the greatest reputation. Women were also employed after the fall of the empire; and it is certain, that, till lately, all civilized nations have employed women only as midwives. This appears even from their names in many different languages, which are all feminine. There were, however, especially in great cities, surgeons who applied themselves to the art of midwifery, and made it their peculiar study. They were sent for

in.

in difficult cases, where the midwives found their incapacity; and then the surgeon endeavoured to deliver the woman by having recourse to instruments useful in those cases, as by crotchets, crows-bills, &c.; but as these cases happened but seldom, women remained in possession of this business. It is certain, according to Astruc, that Maria Theresia wife of Louis XIV. employed women only in her labours; and the example of the queen determined the conduct of the princesses and court-ladies, and likewise of the other ladies of the city. The same author tells us, that he has been assured, that the epoch of the employment of men-midwives goes no farther back than the first lying-in of Madam de la Valiere in 1663. As she desired it might be kept a profound secret, she sent for Julian Clement a surgeon of reputation. He was conducted with the greatest secrecy into an house where the lady was, with her face covered with a hood; and where it is said the king was concealed in the curtains of the bed. The same surgeon was employed in the subsequent labours of the same lady; and as he was very successful with her, men-midwives afterwards came in to repute, and the princesses made use of surgeons on similar occasions; and as soon as this became fashionable, the name of *accoucheur* was invented to signify this class of surgeons. Foreign countries soon adopted the custom, and likewise the name of *accoucheurs*, though they had no such term in their own language; but in Britain they have more generally been called *men-midwives*.

In opposition to this account, which is taken from Astruc, that author tells us, that he is aware of an objection from Hyginus, who asserts, that the ancients had no midwives; which made the women, through modesty, rather choose to run the risk of death than to make use of men on this occasion. For the Athenians, he adds, had forbid women and slaves to study physic, that is to say, the art of midwifery. A young woman, named *Agnodice*, desirous of learning this art, cut off her hair, dressed herself in the habit of a man, and became a scholar to one Hierophilus. She afterwards followed this business. The women at first refused assistance from her, thinking she was a man; but accepted thereof when she had convinced them that she was a woman.

To this account our author replies, that the authority of Hyginus is by no means to be depended upon. His book is full of solecisms and barbarisms; and therefore cannot be attributed to any writer who lived before the fall of the empire; but must have been the work of an author who lived when the Latin tongue was corrupted; that is, about the seventh or eighth century. The contradictions met with in this book also give room to suspect that it is not the work of one hand, but of several. The authority of such a work, therefore, is by no means sufficient to destroy the testimonies of those writers who affirm, that among the Greeks the care of lying-in women was committed entirely to others of their own sex.

The art of midwifery seems not to have been so soon improved as that of physic. Hippocrates, though an excellent physician, seems to have been a very bad midwife. He was acquainted with no other kind of natural labour than that in which the head presents; and condemns footling labour as fatal both to mother

and child: he would have the children in such cases turned, so that the head may present. If, says he, the arm, or leg, or both, of a living child present, they must, as soon as discovered, be returned into the womb, and the child brought into the passage with its head downwards. For this purpose he advises to roll the woman on the bed, to shake her, and make her jump: he proposes the same expedients to procure the child's delivery; and if they do not succeed, he advises to extract it with crotchets, and, whatever happens, to dismember it.

From the time of Hippocrates to that of Celsus, who lived in the reign of the emperor Tiberius, we have no accounts of any improvements in midwifery; but this author gives two very useful directions. 1. In dilating the womb: "We must (says he) introduce the fore-finger, well moistened with hog's lard, into the mouth of the womb when it begins to open, and in like manner afterwards a second, and so on until all the fingers are introduced, which are then to be used by separating them, as a kind of dilater, to distend the orifice, and facilitate the introduction of the hand which is to act in the womb. 2. Children may be delivered by the feet easily and safely, without crotchets, by taking hold of their legs. For this purpose we must take care to turn children, which are otherwise placed in the womb, with their head or feet downwards." It is true, Celsus speaks of a dead child only; but it was easy to conclude from thence, that the same practice might be used with success to deliver a living child. Nevertheless, this was not done; and, notwithstanding the authority of Celsus, the former prejudice continued for a long time. Though Pliny, who lived under the emperors Vespasian and Titus, was not a physician himself, yet by condemning footling labour he attests the opinion of the physicians of his time. He asserts, as a known fact, that footling labour was a preternatural kind of labour: he adds, that children which came into the world in this manner were called *Agrippa*, that is to say, born with a great deal of difficulty.

But however common this opinion was, it was never universally received; and several physicians of character rose up, who, without suffering themselves to be dazzled with the common prejudice, or seduced by the authority of Hippocrates or Galen, recommended and approved of footling delivery. The question then was a long time undecided; and even in 1657, Riverrus, a physician of reputation, condemned footling labour. Mauriceau also remarks, in the first edition of his book on the disorders of pregnant women, printed in 1664, that many authors were still of opinion, that when the child presented with its feet, it should be turned to make it come with its head foremost; but after having observed that it is difficult, if not impossible, to execute this, he concludes, "it is much better to extract the child by its feet when they present, than to run the hazard of doing worse by turning it." All practitioners, however, are now of the same opinion; and the knowledge of midwifery has been so much increased within this century, that it seems to have nearly attained its ultimate perfection, and its operations reduced almost to a geometrical certainty: And this, says Astruc, is not surprising; for, after all, the art of midwifery is reduced to the following mechanical

chanical problem, "An extensible cavity of a certain capacity being given, to pass a flexible body of a given length and thickness through an opening dilatable to a certain degree." This might be resolved geometrically, if the different degrees of elasticity of the womb, and strength and weakness of the child, the greater or lesser disposition of the blood to inflammation, and the greater or lesser degree of irritability of the nerves, did not occasion that uncertainty which physical facts constantly produce in all physico-mathematical questions.

The study of midwifery in Britain as a science is not of very ancient date. The first book published on the subject appeared in the year 1540, and was intitled *The Byrthe of Mankind*, otherwise named, *The Woman's Booke*, by Thomas Raynold, physician. It underwent a second edition by Thomas Ray, a printer whose name is not much known. It was adorned with prints, and went through several editions, and appears to have been held in high estimation. In 1653, the celebrated William Harvey published his treatise on generation; and afterwards engaging in the practice of midwifery, published his *Exercitatio de partu*. Some notice is also taken by Sydenham of the diseases incident to child-bed women, and of those of young children. About this time several other tracts on subjects relating to midwifery appeared, by Wharton, Charleton, Mayow, &c.; but till about the year 1634, Dr Denman considers the treatise of Raynold already mentioned as being the standard. The appearance of the works of Ambrose Paré, which were now first published, depressed the reputation of Raynold's book; and Dr Chamberlen, a celebrated physician, likewise applied himself about the same time to midwifery. He introduced an instrument into the art called a *forceps*, but which Dr Denman supposes to have been a *velis*.—He had three sons who likewise practised midwifery, and, as well as himself, obtained considerable character; and one of the young men went over to Paris with a view to sell the secret, or advance his fortune by a practice which he had found so successful in England. In this, however, he was disappointed; the first case in which he was engaged proved unsuccessful, and he suffered much reproach in consequence. Returning to England, therefore, in 1672, he published a translation of Mauriceau's midwifery, which continued in great estimation for many years.

Dr Willoughby, who wrote a treatise on midwifery, quoted in manuscript by Dr Denman, complains of the practice of midwives about this time. He says, that the books upon the subject all copied one another, recommending methods which could not but be prejudicial to the woman; and that particularly they did not attend to the efforts of nature, but endeavoured to force the birth before the proper time. He was the grandson of Sir Francis Willoughby, so much celebrated in the time of queen Elizabeth; and Dr Denman is of opinion, that the fame and fortune acquired by Dr Chamberlen, induced so many gentlemen as now practised midwifery to undertake the study of it, and to make use of instruments as he did. Among these was Dr Bamber; but others attempted to raise their reputation by a quite contrary practice. In 1723, Dr Maubray published a book on midwifery, intitled, *The Female Physician, or the Whole Art of New Im-*

proved Midwifery, in which he violently declaims against the use of instruments; and next year he published an appendix, under the title of *Midwifery brought to perfection*, in which he sets forth in a pompous manner the improvements he had made. This, however, was no more than a syllabus of his lectures, he having been the first public teacher of midwifery in Britain.

Dionis's midwifery made its appearance in 1719, and Deventer's in 1729. The latter, in Dr Denman's opinion, was more esteemed than it deserved, as he generally condemns the use of instruments; notwithstanding which, he thinks it a considerable acquisition to the science in this country.

In 1727 appeared Dr Simson's work, intitled, *The System of the Womb*; "a work (says Dr Denman) of sufficient ingenuity, but not of much use in practice, even if his theory had been true." Chapman's *Treatise on the Improvement of Midwifery* appeared in 1733. He was the second public teacher of midwifery in London, and was the first who described the *forceps*; the description appearing in the third volume of the *Edinburgh Medical Essays*. His work contains many useful observations. Next year Dr Hody published a collection of cases in midwifery, written by Mr William Giffard. They are 275 in number, occurred in his own practice, and appear to be written with great fidelity. He also gave a plate of the *forceps*; and, in Dr Denman's opinion, was among the first who asserted that the placenta might be attached over the *os uteri*. In 1736, Thomas Dawke published a book, intitled, *The Midwife rightly Instructed*; and, the following year, *The Midwife's Companion*, by Henry Bracken: but these, as well as some others which made their appearance about the same time, are of no importance.

About the same time also, Sir Richard Manningham quitted the profession of pharmacy, and applied to the study and practice of midwifery. He had received the honour of knighthood in 1730; and in 1739 he established a small hospital or ward for lying-in women, which was the first thing of the kind in the British dominions. Here also he gave lectures; and at the same time qualified his students for practice. He became very eminent in his profession, which he exercised with great humanity, and was accounted a man of great learning. He published a work, intitled *Compendium Artis Obstetricæ*; and another, called *Aphorismata Medica*, relating also chiefly to the art of midwifery. In 1741, Sir Fielding Oulde of Dublin published *A Treatise of Midwifery*; the most important parts of which are some observations on the continuance of the thickness of the uterus during pregnancy, with his description of the manner in which the head of the child passes through the pelvis at the time of the birth; the truth of which observations have since been universally acknowledged.

From this time the English, according to Dr Denman †, might be said "to have been in full possession of the subject; all the books written in the neighbouring countries being translated, public lectures given, and an hospital established for the further improvement of the art: and as all the books printed since that time may readily be procured, every gentleman has an opportunity of forming his own opinion of their respective merits. But the college of physicians (adds he),
† Introduction to the Practice of Midwifery, p. 1.
having

having been pleased, in the year 1783, to form a rank in which those who dedicate themselves to the study of midwifery should be placed, I trust that future accounts will be more correct; and that this measure adopted by the college will promote the public benefit, by confining the industry and abilities of one class of men to this branch of the profession."

In Scotland, though there has for a long time been professors of midwifery, yet the surgeons likewise practise that art as well as their own. Several approved

treatises on the subject have appeared in this country; particularly a system by the late Dr Smellie, which has been long held in the highest estimation in both kingdoms; and, within these few years, several excellent performances by Dr Alexander Hamilton of the university of Edinburgh: And, indeed, we may venture to affirm, that both theory and practice of midwifery are as well understood in this kingdom as in any part of the world.

PART I. THEORY OF MIDWIFERY.

Description
of the
Pelvis in
general.

THE subject of this Part comprehends, in a particular manner, the anatomical structure of the pelvis, and other parts concerned in the formation of the child, the theories of conception, generation, &c. of the nutrition, growth of the foetus, and of the powers by which it is expelled. Of all these some account has been given under other articles; but as the particular description of the pelvis belongs peculiarly to this subject, we shall here give an account of its various conformations, as they in a great measure affect women at the time of child-bearing, and very particularly contribute to the ease or difficulty of the labour.

CHAP. I. Description of the Pelvis in general.

Dr DENMAN observes, that the term *pelvis* has been applied indiscriminately to the inferior cavity of the abdomen, and to the bones which form that cavity; but he thinks it most proper to confine it to the bones, and to distinguish the hollow by the name of the cavity of the pelvis. In the state of infancy, the pelvis is composed of five or six bones, most of which in the foetus are soft and flexible; some of them being, in a manner, quite cartilaginous; while the edges of others are found covered with a substance of the same kind. This construction is thought by some to facilitate delivery, as the pelvis of the foetus can thus change its figure like the cranium; but M. Baudelocque thinks this an erroneous opinion, "consonant neither to reason nor experience."

In the adult the pelvis consists only of four bones, viz. the *sacrum*, the *os coccygis*, and the two *ossa innominata*. These being already described under the article ANATOMY, we shall here content ourselves with observing, that an anchylosis is not unfrequently formed between the *os sacrum* and the *ossa innominata*; and sometimes an imperfect joint in consequence of their separation; whence the part is very much weakened, and the person ever afterwards walks with difficulty.

The *os coccygis* in infancy is cartilaginous; but in the adult it is composed of three, or more frequently of four bones, connected by intermediate cartilages, the uppermost of which is somewhat broader than the lower part of the *os sacrum*. In some subjects these bones coalesce, and form a single one: in others an anchylosis is formed between the *sacrum* and *os coccygis*; in consequence of which the latter is shortened and turned inwards, so as to obstruct the head of the child in its passage through the pelvis. But the impediment thereby occasioned at the time of labour may be overcome by the force with which the head of the child is propelled, and the *os coccygis* again separated

from the *sacrum* with a noise loud enough to be distinctly heard. In general, however, some regressive motion is preserved between the bones of which the *os coccygis* is composed; and that which is produced between the *sacrum* and *os coccygis*, when the latter is pressed by the head of a child passing through the pelvis, occasions a considerable temporary enlargement of the inferior aperture of the pelvis. Any lateral motion is prevented by the insertion of the *coccygai* muscles, part of the *levatori ani*, and some portions of the sacro-sciatic ligaments into the sides of the *os coccygis*.

The *os innominatum*, in a woman of the ordinary size, is about six inches broad from the anterior to the posterior superior spine. The height is nearly six inches and an half from the anterior spine to the bottom of the tuberosity of the ischium, and seven and an half if taken from the middle of the crista of the ilium; and hence we may in some measure be enabled to determine the depth of the cavity of the pelvis laterally from the superior to the inferior strait.

"The *ossa pubis* (says M. Baudelocque†) are joined together by means of a substance which has always been described by the name of cartilage, though it differs as much from that as from a ligament. According to some anatomists, each *os pubis* is covered by its own cartilage. Their junction not a true synchondrosis; but a close articulation, which admits only of insensible motions. By carefully examining this symphysis, we observe that each *os pubis* is really covered by a cartilage at its anterior extremity; that this cartilage is thicker before than behind, and in its superior and inferior parts than in the middle of its length; that these bones, thus covered, are bound together by means of a substance which seems ligamentous, and whose fibres, which are mostly transverse, go from one to the other; that these fibres are so disposed, that the deepest are the shortest, and the most superficial the longest; that they leave between one another a kind of meshes filled with reddish corpuscles, very like those which are seen about the moveable articulations, and which are commonly thought to be synovial glands. We observe farther, that this fibrous and ligamentous substance does not occupy the whole thickness of the symphysis, and does not bind the bones together through the whole extent of the surfaces presented by their anterior extremities; but that there exists a true articulation of the species known by the name of *arthrodia*. If we open this symphysis towards the inside of the pelvis, after a cellular tissue very thin and loose, which we meet with first, we discover a capsular membrane, whose most apparent fibres are transversal; afterwards

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of the
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† System of
Midwifery,
translated
by Mr
Heath.

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terwards two cartilaginous facettes, smooth, polished, and moist, from six to eight lines long and two broad, of a figure a little semilunar, lightly convex on one bone and concave on the other. These facettes comprehend nearly the middle third of the length of the symphysis and the posterior third of its thickness.— This symphysis then presents in one third of its extent, or thereabouts, a true articulation; and in the rest a *syneurosis* and *synchondrosis* at the same time.

“ This compound and articular substance, being detached from the bones, forms a kind of wedge, whose base constitutes the anterior part of the symphysis, and its edge the posterior; so that these bones seem to touch towards the inside of the pelvis, and appear separated to the distance of several lines without: The base of this kind of wedge is generally from four to six lines broad towards the middle of the length of the symphysis, and from eight to ten in the inferior and superior parts, while the edge at most does not exceed one line. Its thickness, taken according to that of the bones, is greater above than below; where this substance, become thinner, forms what is called the triangular ligament.

“ This first means of union was not sufficient to give these bones the firmness necessary for the free exercise of the functions to which the pelvis is destined. It is covered and fortified in all parts, but especially before, by bundles of ligamentous and aponeurotic fibres. Independently of the thick and very strong ligamentous structure which forms the fore-part of the symphysis, we observe bundles of tendinous fibres which decussate each other a thousand ways, some of which arise from the interior *graciles* and the external *obturator*s, and others from the external portions of the inguinal rings. The triangular expansion which terminates the symphysis inferiorly, and which forms the top of the arch of the pubes, seems to have other uses than that of binding the bones together.

“ The manner in which the *os sacrum* is connected with the *ossa innominata*, differs considerably from that in which the *ossa pubis* are joined. Here each articular facette is covered by a true cartilaginous layer, and there are inequalities on each side, which mutually receive one another, while nothing of that kind is observed in the junction of the pubes; neither are there in any part of these articular facettes any of the transverse fibres which go from one bone to the other in the *ossa pubis*: these articulations, therefore, derive all their strength from the great numbers of ligaments which surround them. Most of these are very short, and do not extend beyond the edges of the articular facettes: but there are others longer to be seen above, below, and behind these symphyses.

“ The *os sacrum* is not only articulated with the ilia, but with the spine and coccyx. It is joined in three places to the spine: 1. By an oblong and cartilaginous impression in the middle of the basis, which unites it to a similar impression in the body of the last lumbar vertebra, by means of an elastic substance. 2. By two little articular masses fixed in the posterior edge of that first impression, and which answer to similar substances in the vertebra above-mentioned.

“ The elastic substance which unites the middle of the base of the sacrum to the spine, is entirely similar in its nature to that seen between the bodies of

all the vertebrae. Being very thick before and thin behind, the angle resulting from the disposition of the articular facettes of these two parts is rendered more obtuse. This *sacro-vertebral* junction is surrounded by an infinity of ligaments, some without and others concealed within the spinal canal. All motion is not prohibited by this kind of junction; but, as it only depends on the compression of the intermediate substance, it can be but very small. The motion between the body of the last lumbar vertebra and the base of the sacrum, is never extensive enough to make any alteration in the degree of acuteness of the angle which results from their junction; but the convexity of the lumbar column may be augmented or diminished by means of a compound motion, formed of those which take place between each of the lower lumbar vertebrae and between the lower ones of the back. This augmentation or diminution of the convexity, in proportion as the trunk is bent backward or forward, or by raising or lowering the breech when the woman lies on her back, deserves particular attention in the practice of midwifery; for thus we may make a favourable change in the direction of the axis of the pelvis, relatively to that of the trunk, to that of the uterus, and in the direction of the expulsive forces of the latter, which may be rendered more or less efficacious according to circumstances, by making the woman preserve a proper attitude.

“ The junction of the coccyx with the sacrum permits the former to move, and yield to the different degrees of pressure it undergoes in different circumstances. The mobility is very great in youth; but diminishes insensibly as the patient grows older, and at last is totally lost. If entirely lost, or considerably diminished, before a woman is past child-bearing, it produces sometimes, though very rarely, an obstacle to delivery. The connections of the pelvis with the inferior extremities are not of much importance in midwifery. The natural course of labour cannot be disturbed by any fault in their configuration when the pelvis itself is well formed; but in general they are consequences of a deformity of it. They are *enarthroses*, which allow of motion in every direction.”

The pelvis is divided into two parts, called the *upper* and *lower*, by a ridge sometimes elliptical, and sometimes of other shapes. The breadth of the upper part from the anterior superior spine of one ilium to another, is usually eight or nine inches, and its depth from three to four. At the back part of it is the projection of the lumbar vertebrae, and at the sides the *iliac fossae*. The lower part forms a kind of canal, whose entrance and outlet are somewhat narrower than the middle; whence it has been distinguished into the *superior* strait, the *inferior* strait, and an excavation.— The *superior* strait is a kind of circle forming the entrance of the canal; its form, however, is various, as is also its obliquity from behind forwards. M. Levret has fixed this last at an angle of from 35 to 40 degrees.

The smallest diameter of this strait is generally about four inches, extending from the middle of the projection of the sacrum to the superior and internal part of the symphysis of the pubes. The other diameter

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diameter is usually about an inch longer, extending from one side of the strait to the other. The oblique diameters are a medium betwixt the two former, extending diagonally from each acetabulum to the sacro-iliac junction of the opposite side. The pelvis is cut at right angles by the two former, and into acute ones by the latter; but the diameters, considered in relation to delivery, are somewhat different from those just mentioned, some changes in them being occasioned by the soft parts within the pelvis.

The inferior strait is in general smaller, and of a more irregular figure than the other, being not formed like it entirely of bones. The edge, rendered unequal by three deep and large notches, is completed behind and at the sides by the sacro-ischiatic ligaments, forming a kind of circular notch before, called the *arch of the pubes*. The diameters of it are commonly about four inches in length; and though the transverse, which extends from one *ischium* to the other, be often a little longer than that which extends from the fore to the back part, it must be reckoned the smallest with regard to delivery; because the latter augments in proportion as the point of the coccyx recedes from the pubes. We must also remember, that the great diameter of the inferior strait is parallel to the smallest of the superior, and that it crosses the longest of that strait at an angle more or less acute; and by carefully attending to this, we may, in many cases, with the finger alone, when properly directed, remove obstacles which could not have been overcome even by means of instruments, without exposing the child to great inconveniences. It is likewise favourable to delivery that the middle part of the pelvis is a little larger from before backwards than the straits; which disposition proceeds from the curved figure of the *os sacrum*.—On one side this curve diminishes the numerous and long-continued frictions which the child's head would necessarily undergo if the pelvis were equally broad in all its parts; and on the other side it is equally useful in preventing the effects of a long and forcible pressure on the sacral nerves, which a flat form of the sacrum would have rendered unavoidable during the whole time of the passage of the head. The cavity of the pelvis is commonly from four to five inches deep behind, three and an half at the sides, and one and an half at most before.

The arch of the pubes, which at the top is only from one inch and a quarter to one and two-thirds in breadth, augments gradually as it descends; so that at the bottom its sides are three inches and an half, or even four inches, separated from one another; that is, if we take the line which is looked upon as the transverse diameter of the inferior strait for its base; the height being about two inches.

The axis of the superior strait of the pelvis cannot well be determined; but that of the inferior one, with regard to delivery, must be considered as passing through the centre of the opening of the vagina dilated by the child's head. Its direction is then so much inclined from behind forward, that its superior extremity traverses the lower part of the first false vertebra of the sacrum, and crosses that of the other strait at a very obtuse angle.

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Hitherto we have treated only of that form of the pelvis which is most favourable for delivery: but the proportions and forms of it are various; and as it differs from those above described, the delivery is attended with more or less difficulty.

The defects of the pelvis, with regard to facility of delivery, consists in its being either too large or too small. At first sight it might be imagined, that a large pelvis would make the delivery more easy, as the head of the child will thus be exposed to fewer frictions, be more easily expelled, and the labour be less painful. But women who have a very large pelvis, are subject to those inconveniences which arise from an obliquity of the uterus, or even to a descent of it altogether; especially in the time of labour, when that viscus, being already charged with the weight of the child, is entirely subjected to the expulsive power of the abdominal muscles. In women who have had several children, the uterus is but weakly retained by its ligaments; and in subsequent pregnancies it descends still lower, until at last it rests on the margin of the pelvis. This, however, does not take place before the conclusion of the first four or five months: before that time its weight lies principally on the extremity of the rectum; and by this, as well as by its bulk, the discharge of the urine and faeces is impeded, and accidents sometimes ensue from the compression of the veins which pass through the pelvis. These symptoms sometimes vanish about the middle of pregnancy, but re-appear towards the latter end; because the head of the child is early engaged in the pelvis, and acts on the same parts that the whole uterus did before. Besides all these accidents, there are others which may take place at the time of delivery; so that, upon the whole, it cannot be reckoned any real advantage for a woman to have a large pelvis.

The accidents, however, which arise from too great a size of the pelvis, are much more easily remedied, and in themselves less dangerous, than such as arise from its narrowness. This defect may be considered as either relative or absolute. The former arises from an excess of size in the head of the child; the latter from a bad conformation of the pelvis itself. The absolute narrowness of the pelvis rarely affects all parts of it at once: it is generally found only in one of the straits; in which case, the other is usually of the natural size, nay, sometimes even larger than natural. The fault is more frequently in the superior than the inferior strait; and it is remarkable, that it most commonly affects the strait in its small diameter; very rarely in its transversal; sometimes affecting only one side. In the inferior strait it is generally caused by the approximation of the tuberosities of the ischia.

"It is easy (says M. Baudelocque) to determine why the superior strait is more frequently deformed than the inferior; and why it is almost always between the pubes and sacrum that it is defective respecting delivery. If we consider the direction of the forces which act on the pelvis of rickety children, in whom the bones are at the same time softer and more loosely connected than in the natural state, we shall see, that the greater part of those forces tend to carry the base of the sacrum forward and the *os pubis*

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pubis backwards. Whether the child be standing or sitting, if we attend to the direction of the spinal column, we shall see that the weight of the body must insensibly push the base of the sacrum towards the pubes; and that it acts in the same manner on the inner parts of the acetabula, which serve as a fulcrum to the inferior extremities when the child is standing or walking. The *ossa pubis*, particularly in these latter cases, must be pushed towards the sacrum; in such a manner, however, that their posterior extremities often approach a little nearer to the projection of the base of that bone than their anterior extremities, or the symphysis. If the superior strait does not constantly present the same figure in deformed *pelvices*; if it is sometimes larger on one side than the other; if one of the acetabula is nearer to the sacrum, while the other approaches less; if the symphysis of the pubes is removed, in many cases from a line which would divide the body into two equal parts—it is because the rickets have not equally affected all the bones of the pelvis, nor equally hurt all their junctions; and because the attitude which the child takes in walking or sitting may change a little the direction of the compressing powers just mentioned. The weight of the body may also equally hurt the form of the inferior strait, but variously, according to the most usual attitude of the child and the direction taken by the spinal column. For example: If it sits much, the sacrum will be more curved, and the strait more contracted from before backwards: in this attitude, if it inclines habitually to one side, one of the ischiatic tuberosities will be thrown inwards, the *os ilium* will be more elevated, &c. The action of the muscles which are attached to the pelvis, the pressure of cloaths, and that which the arms of the nurse exert on this part, contribute also something to the deformities in question, but much less than the weight of the trunk: whence we see, of what importance it is to keep rickety children in bed, and leave them at liberty; instead of obliging them to walk, to sit up, or have them constantly in the arms, as is done almost every where."

The dimensions of the pelvis itself vary no less than the contour of the straits. If the diameter of some, taken from the pubes to the middle of the projection of the *os sacrum*, be only a few lines; in others the defect is several inches, so that scarcely a single inch is left between these bones. These extremes, however, are not frequently met with; and the latter of them is never so great in the inferior as in the superior strait. On comparing the dimensions of a well-formed pelvis with those of a child's head, we shall find that the former might admit of being some inches less in circumference, and yet be large enough for an easy delivery. The circumference of a common head is usually no more than ten inches and a quarter, or ten and an half. The first degree of narrowness in any pelvis therefore must be, when each diameter is something less than three inches and an half. M. Baudelocque says, that he has seen pelvices in which the distance of the pubes from the sacrum superiorly was no more than six or eight lines; and he had in his possession two others, in one of which the distance from the back of the right acetabulum

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to the projection of the sacrum was only three or four lines, and the other had but 14 lines between that projection and the symphysis of the pubes.

The narrowness of the pelvis is to be accounted one of the principal causes of difficult delivery.—When an opening of only three inches and a quarter is left, the labour must be more difficult than when it is three inches and an half, as the number of frictions which the child's head must undergo are then more numerous and frequent. When there is an opening only of three inches, the labour must be still more difficult; but still there are instances of natural deliveries without any assistance, notwithstanding the disproportion betwixt the size of the child's head and pelvis. This may even happen when the diameter of the pelvis is still smaller, such as two inches and three quarters, or two and an half. M. Solayres observed in a case of this kind, that the head was lengthened in such a manner, that its longest diameter was eight inches all but two lines, that which goes from one parietal protuberance to the other being reduced to two inches five or six lines; and M. Baudelocque has observed similar changes in the form of the head, and the respective lengths of its diameters at the instant of birth, where the child was equally deformed, the long diameter being seven inches, and the transverse one two inches six or seven lines. The children were in good health; and the day after their birth their heads wanted very little of the usual proportions.

But when the small diameter of the pelvis is less than two inches and an half, the head of the child cannot pass; and then some of the dangerous surgical methods must be undertaken, which frequently prove fatal both to the mother and child. Even when the pelvis is two inches and an half in diameter, the natural delivery is not always without danger to both; as, on one hand, the soft parts which cover the pelvis are subjected to such violent pressure that they become inflamed, exquisitely painful, and at last are even threatened with gangrene; on the other, the bones of the child's cranium riding over one another, or sometimes fractured and depressed, wound the brain, and produce internal extravasations which generally prove fatal. The bad consequences resulting from a deformed pelvis, show themselves sooner or latter, according as the superior or inferior strait is vitiated. When both are so, the obstacles to the birth begin to manifest themselves as soon as the labour begins; and sometimes those at the superior strait are so great, that the expulsive powers are exhausted, and the head stops there; or if it be pushed farther into the pelvis, and stopping there, it will remain incapable of being delivered without the assistance of art. The head cannot pass this strait without being in a considerable degree elongated; and when it enters the pelvis, the cavity being there sufficient for it, it naturally returns to its former dimensions, at least in part, and more or less so as it stays a longer or shorter time. The same conformation of the head, however, which enabled it to pass the first strait, is still more necessary to enable it to pass the second: and hence the symptoms which had come on with the first pains, sometimes disappear in a great measure during the time that the head stays in the excavation; but increase to

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a greater degree than ever when the strong labour comes on.

When the superior strait alone is contracted, the head advances at first with great difficulty; but as soon as the parietal protuberances have cleared the strait, the other parts of the pelvis being relatively or absolutely larger, the head passes them with so much ease, that the delivery is frequently terminated by a few pains. The contrary is observable when the fault is in the inferior strait, if the first be of the usual size. The head then descends easily into the lower part of the pelvis; but cannot proceed any farther, until it overcome the obstacles which obstruct its course, and render it difficult and laborious. In this case, the symptoms attending obstruction appear later than in the former. In these cases, however, it is necessary that the practitioner should accustom himself by practice to form a just estimate of the powers of nature, otherwise he may easily deceive himself; in the former, supposing that a delivery is impossible; and in the latter, that a delivery will be easy which cannot be effected without the assistance of art. An instance of this is given by our author, in a case to which (he says) more than forty persons were witnesses.

The operator pronounced that the woman would be speedily delivered, on account of the facility with which the child's head had engaged with the first pains; and attributing the obstacles which soon after obstructed its course to another cause, rashly destroyed the child by using the crotchet, when its life might have been preserved by other means, having waited two days in blind security, expecting a natural delivery. M. Baudelocque obtained possession of the pelvis of this woman after she died; and tells us, that the circumference of the superior strait of the pelvis, when divested of all its coverings, measured 14 inches, but the inferior only *nine*. The distance from the point of the os sacrum to the symphysis of the pubes, as well as the interval between the ischiatic tuberosities, was but three inches. The cavity of this pelvis diminished insensibly in breadth from one strait to the other, and was as regular as possible in its contour.

The excavation, or middle part of the pelvis, is much more seldom defective in its form than the straits; and when this is the case, it must arise from some exostosis, or from the sacrum describing a right line in its anterior part, instead of being curved as usual. The straight and flat form of the sacrum generally produces fewer obstacles to delivery than the too great curvature of it. The former fault generally affects only the cavity of the pelvis, and cannot hinder the passage of the child, if the canal be otherwise well disposed: but the latter, or too great a curve of the sacrum, commonly proves injurious to both straits, contracting them from before backwards, and at the same time diminishing the depth of the pelvis at the back part, as well as the respective height of the arch of the pubes. In these cases the head, though it passes the first strait with difficulty, cannot pass the second; being stopped in its course by the inferior part of the sacrum before the occiput is long enough to engage under the arch.

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Labours may also be rendered difficult by too great a length of the symphysis of the pubes; a want of elevation, or breadth of the arch of these bones; the length and wrong direction of the ischiatic spines, as well as a consolidation of the coccyx with the point of the sacrum. These faults, however, are very rare, if we except the consolidation of the coccyx: they are scarce ever met with alone, and are generally the consequences of a bad conformation of the rest of the pelvis. Even this consolidation, however, though more common than the other faults, yet cannot obstruct delivery so frequently as has been imagined; and when it does so, it is only in women who have a narrow pelvis. Our author denies the position laid down by some, that the head of the child, in all cases, pushes back the point of the coccyx half an inch, or even a whole inch. Those who assert this (he says) know not the relation betwixt the dimensions of the head and the inferior strait in most women. Whence he cannot recommend a precept founded upon this principle, by which it is directed to push back the coccyx, when the head, though low down, cannot disengage itself easily.

We must now consider a subject on which the writers upon midwifery have been greatly divided, viz. the separation of the bones of the pelvis in the time of labour. Some have imagined that this separation took place in all labours; others that it happened only in difficult cases; some, that it indicates a morbid state; and some that it was quite impossible.—M. Baudelocque allows the possibility of such a separation, but denies that it happens so frequently as is imagined. "Experience (says he) demonstrates, that this separation, far from being common, is very rarely met with, and is not more usual after a laborious than after an easy labour, nor in a distorted pelvis than in one well formed. I have sought for it twenty times in all these cases, by opening the bodies, and have scarcely met with one which could remove all doubt of its existence." In those cases where it takes place, he is of opinion, that the filtration of serum into the ligamentous tissue of the symphysis, must be regarded as the usual predisposing cause. The remote cause, of consequence, must be whatever produces this filtration. This, he thinks, cannot be done merely by the pressure of the gravid uterus on the trunks of the vessels which are distributed to these symphyses. An alteration in the fluids themselves he supposes likewise to be necessary.

But though the predisposing cause of this separation must be the relaxation of the symphyses by the infiltration of serum, we are not to look upon the swelling of the cartilages by means of this infiltration to be the immediate cause: For however the ligaments may be relaxed, the cartilages which incrust the extremities of the ossa pubis, as well as the articular facettes of the ossa ilia and the sacrum, are no thicker; so that they cannot, as some have supposed, act like wetted wedges by which large blocks of stone may be cleaved. "The wedge by which the bones of the pelvis are separated (says our author), does not act between the extremities of these bones, but in the circle formed by their assemblage in the pelvis itself: it is the uterus charged with the produce of concep-

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tion in the latter periods of pregnancy, and the child's head forced down by the action of the uterus, and of the abdominal muscles in time of labour."

This separation, however, is not always the effect of a relaxation and stretching of the ligamentous tissue of the symphysis. In some cases, where the obstacles which obstruct the passage of the child are very great, and the efforts for its expulsion very strong and lasting, the symphyses tear, and permit the bones to separate much farther than they could have done by a simple relaxation. "I must add (says our author) that it is not the symphysis of the pubes, properly speaking, which tears; for no effort can break the ligamentous substance which unites these bones to each other; the symphysis detaches itself from one of them, and leaves the bone naked." The separation in question has likewise frequently taken place in instrumental deliveries, to which the natural efforts seemed to contribute nothing; and it has also been found in consequence of a stroke or fall.

"Being deceived in the principle of this separation (says M. Baudelocque), they necessarily erred in the consequence deduced from it. It has been so firmly believed to take place in all labours, that it was thought to be absolutely necessary; and that without it many women could not be delivered without extreme difficulty. Having thus mistaken the necessity and pretended advantages of this separation, the natural resistance of the symphyses, and above all the dryness and rigidity necessarily induced in them by age, were consequently reckoned among the causes of difficult and laborious births. Obstacles have been attributed to the state of these symphyses, which merely depended on the resistance of the neck of the uterus, and of the external parts; and it has been recommended to moisten and relax them by the use of baths, cataplasms, lineaments, fomentations, &c. But what can be expected from such methods, when delivery is obstructed by a narrow pelvis? Will any one venture to assert, that he has once by such means obtained the effect he expected, and that he has thus assisted labours which could not otherwise have been terminated but by the Cæsarean operation, as has so often been published? I should have dispensed with demonstrating the fallacy which has prevailed on this point, if it had not led some practitioners into a very serious consequence. In order to appreciate all these means, and fix the degree of confidence to be placed in them, supposing that they could operate to the relaxation of the symphysis of the pelvis, it is necessary to determine what degree of amplitude can be given to that cavity by the separation of the bones which constitute it. The ossa pubis cannot separate without augmenting the circumference of the pelvis; but how much will its diameter be increased? If the circumference were perfectly circular, every possible diameter would partake a third of that augmentation; but as the entrance of the pelvis is in general the more elliptic as it deviates more from its natural state, it follows, that its different diameters cannot increase in the same proportion; and we may say that there is none but the transverse one which can become larger. In a moderate separation the *antero-posterior* diameter is scarce at all augmented; and it has been repeatedly demonstrated, that the ossa pubis must sepa-

rate at least an inch to procure two lines in that direction; while the transverse diameter shall be increased six lines, and often more.

"The pelvis being larger in most women than is necessary for their delivery, the separation of the bones could be of no advantage to them, nor render their delivery more easy. Far from regarding it, with some ancient authors, as a benefaction of nature, we ought to consider it as an additional source of inconveniences in those women who are subject to it: for, on one side, we see that a pelvis too large exposes the woman to a number of accidents; and on the other, that there are some which inevitably accompany the separation, and the mobility of the bones which form that cavity. Far from favouring delivery in all these cases, it could not but render it more tedious and painful to the woman, as experience has convinced me. If we ought to expect any real advantage from it, considering it only with respect to the passage of the child, it could only be in those women who have the pelvis deformed, and where the defect which rendered delivery impossible did not exceed two lines at the most; since a separation of an inch cannot procure an augmentation of more than two lines in the small diameter of the superior strait, which is almost always that which occasions the greatest obstacles to the exit of the child. If from a separation of an inch, which has never taken place between the ossa pubis without a rupture of their symphysis, we are not to expect an augmentation of more than two lines in the direction of the little diameter of the superior strait, what can we obtain from a separation always much less, and so little apparent in most women that we may doubt its existence? The examination of a great number of women who have died in child-bed, has proved to me that it is excessively rare for the separation in question to amount to two lines; and I never found it exceed that but once. But supposing (what is impossible) that art could procure a separation of an inch between the ossa pubis without dividing their symphysis, what practitioner would dare to affirm, without fear of being deceived, that the volume of the child's head did not exceed the little diameter of the superior strait by more than two lines? If it is difficult to estimate justly the degree of opening in the pelvis, it is much more difficult still to judge of the child's head; and it is only by taking the mean between the largest and the smallest that we usually establish the relation of its dimensions to those of the pelvis; but a *thereabouts*, in the case supposed, cannot supply the place of that precision which would be necessary."

From his reasoning upon this subject, M. Baudelocque concludes directly against the operation of cutting the symphysis of the pubes, as being not only useless, but attended with very dangerous consequences. "When this separation (says he) has been suddenly made, severe pains in the parts divided, an impossibility of walking, and sometimes even of moving the inferior extremities, inflammation, fever, abscesses, caries, and lastly death itself, have generally been the effects of it: but when a relaxation only takes place, the consequences are less severe; a painful and tottering walk being the only symptom attending it. If the relaxed symphysis at last grow firm again, if the bones of the pelvis recover their former stability, if the

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the lameness goes off entirely in some women, how often, on the contrary, have we not observed an inability to walk, or even to move the legs, without violent pain, continue for years afterwards?"

These violent symptoms frequently attend even slight separations of the bones in question. M. Baude-locque gives an instance of a woman who had kept her bed ten months, being all that time afflicted with the most excruciating pains in the junction of the ossa pubis, and of one of the ilia, with the sacrum, whenever she attempted to move the inferior extremities, though no separation of the symphysis could be discovered, nor any thing besides a slight mobility in that of the pubes. The accident had been perceived during the time of labour, and the midwife had been accused of luxating the bones.

Dr Denman has also treated this subject at considerable length. He informs us, that for many centuries it was believed that these bones were always separated during the time of labour; or that there was a disposition to separate, and an actual separation, if the necessity of any particular case required that enlargement of the cavity of the pelvis which was consequent to it. The degree of separation was also supposed to be proportioned to such necessity; and when this did not happen naturally, instruments were made use of for distending the parts: and, on the same principle, the section of the symphysis of the pubes has been recommended. "This opinion (says he) ought probably to be assigned as one reason for the superficial notice taken by the early writers on midwifery of those difficulties which are sometimes found to occur in parturition from the narrowness or deformity of the pelvis. To this may also be referred much of the popular treatment of women in child-bed, and many popular expressions in use at present. But this opinion has been controverted by many writers, who assert, that there was neither a separation nor a disposition to separate; but that, when either of them did happen, they were not to be esteemed as common effects attendant on the parturient state, but as diseases of the connecting parts. The disputants on each side have appealed to presumptive arguments, and to facts proved by the examination of the bodies of those who died in child-bed, in justification of their several opinions. But, notwithstanding all that has been said, I know not that we are authorised by the experience of the present time to say, that a separation, or a disposition to separate, prevails universally at the latter part of pregnancy, or at the time of labour: yet that these effects are often, if not generally, produced, may be gathered from the pain and weakness at the parts where the bones of the pelvis are joined to each other before and after delivery. In some cases also pregnant women are sensible of a motion at the junction of the bones, especially at the symphysis of the ossa pubis; and the noise which accompanies it may sometimes be heard by the bystanders.

"A strong presumptive argument in favour of the separation of the bones has been drawn from quadrupeds. In these the ligaments which pass from the obtuse processes of the ischia to the sacrum, on which the firmness of the junction of the bones very much depends, and which at all other times resist any im-

pression attempted to be made upon them, are for several days previous to parturition gradually deprived of their strength, and the animal walks in such a manner as would incline us to believe could only be produced by a separation of the bones of the pelvis. Now it is not reasonable to conclude, that a circumstance which generally takes place in one class of viviparous animals should never occur in another, especially in a matter in which there is not essential difference."

Notwithstanding these arguments, however, Dr Denman does not look upon the matter to be yet absolutely decided. No person, he says, who has been conversant in the dissection of women who have died in child-bed, can have wanted opportunities of seeing every intermediate state of these parts, from a separation in which the surfaces of the bones were loosened and at a considerable distance from each other, to that in which there was not the least disposition to disunite.

When this separation takes place beyond a certain degree, it is to be looked upon as morbid: and, he says, that it may be produced by the two following causes. "1st, A spontaneous disposition of the connecting parts. 2^{dly}, The violence with which the head of the child is protruded through the pelvis." Of each of these cases he gives an example.—The first was of a young lady of a healthy constitution, who had been married in the 21st year of her age, and in 1774 was delivered of her third child, which was unusually large, and the labour was severe and tedious. For several days before delivery she had been so much afflicted with pain and weakness in her loins, that she could not walk without assistance. She recovered without any unfavourable circumstance, excepting that for several weeks she was incapable of standing upright, or putting one foot before the other; the attempt to do either being attended with pain and a sensation of looseness and jarring, both at the parts where the ossa innominata are joined to the sacrum, and at the symphysis of the ossa pubis. By the use of strengthening medicines she recovered, and in a few months was perfectly well."

It being suspected that the complaints above mentioned had proceeded from too frequent parturition, she was advised to suckle her child for a longer time than usual; and accordingly continued a nurse for 15 months. Soon after this she became with child a fourth time. The complaints which had accompanied her former pregnancy now came on sooner, and with greater violence than before, insomuch that for three weeks before delivery she could neither walk nor stand; and there was reason to suppose that the bones of the pelvis were separating. She was delivered on the 7th of July 1777, the labour being accompanied with faintings, great irritability, and a total inability to move her inferior extremities. A few days after her delivery she had a fever, which terminated in an abscess in one of her breasts, by which she was confined to her bed for near seven weeks. In nine weeks she could walk with crutches, and received considerable benefit by being sent into the country; and likewise, as she imagined, by drinking half a pint of infusion of malt twice a day. In about five months she was able to walk without assistance; though sometimes sensible

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of the motion of the bones, which seem never to have been perfectly united.

About Christmas the same year, this lady became again pregnant; and in the month of July 1778 she began to feel an inability to move; which, however, was attributed to the heat of the weather: but on a sudden the pain and weakness of her back returned to such a degree, that she could walk no more till the 11th of October, when she was delivered of a fine child, but after a most severe and tedious labour, occasioned in a great measure by her being totally unable to move. The symptoms after her delivery became very extraordinary and alarming. On the fourth day a fever came on; and though this was soon removed, the pain at the junction of the bones still continued. She had no command of her inferior extremities; and the pain, when she was moved, became so excruciating, that she felt as if tearing asunder. Her stomach was at all times much disturbed; but when the pain became violent, a nausea, vomiting, or hiccough came on. Strange sympathies were produced in various parts; as a tearing cough, sneezing, sense of weight in her eye-lids, which could not be kept open though there was no inclination to sleep. There was a noise in the bowels, and other nervous affections, all of which ceased when the pain was allayed by opiates.

Having remained for several months in this deplorable situation, it was at last thought proper to raise her from her bed, and cause her to make an effort to stand or walk, lest her complaints should be made worse by such a long course of inactivity. She had now, however, totally lost the power of supporting herself; the motion of the bones was plainly perceived; and the consequences of every trial were so painful, that there was a necessity for desisting. In 1779 she was removed, upon a couch, in a boat to Margate, for the benefit of the air and sea-bathing, from which she was always sensible of receiving advantage. In this place she continued to reside; and in eight years after her delivery became able to walk without crutches.

The second case was of a young woman of a healthy but delicate constitution, who was in labour of her first child. The pains were so strong, that the head of the child was forced through the external parts, and the perinæum supposed to be lacerated, in spite of all the opposition which could be made. At the instant when the head of the child was expelled, the operator perceived something to jar under his hand, and was even sensible of a noise, which he attributed to the laceration of the perinæum. In a little time the placenta was extracted without hurry or violence; and a few drops of *tinctura opii* were given to allay the uneasiness which took place, and was supposed to be occasioned by *after pains*. On the following days, however, she complained of an uneasiness in the region of the abdomen; but no particular notice was taken of it, as the milk was regularly secreted, and there was no symptom of fever; but on the fourth day, when taken out of bed, she was found to be unable either to stand or sit on her chair by reason of the pain and weakness in the part of which she originally complained. This was afterwards conjectured to arise from a separation of the bones of the pubes; to which conjecture the long continuance of the com-

plaint seemed to give countenance. The conjecture was founded on the positions and attitudes in which the patient sought to find relief. The symptoms were as follow:—When she endeavoured to stand upright, which she could do better upon one foot than both, and with her feet close than at a distance, together with the pain at the symphysis, she had a sense of extreme weakness, accompanied with a faintness. When she first sat down on her chair, resting her elbows upon the arms, the complaints became tolerable. When she had remained a little time in this position, they again became importunate, and she supported herself with her hands upon her knees, and presently bent forwards, so as to lean her elbows upon her knees: this position becoming irksome, she was obliged to return to her bed, where she became immediately easy. When she first attempted to walk, she was compelled to bend forwards in such a manner as to rest her hands upon her knees, making a straight line from her shoulders to her feet. At the end of 14 weeks, whilst she was in a coach, into which she had often been lifted for the benefit of air and exercise, she had a discharge which she supposed to be menstruous; but which, though it ceased before her return, gave immediate relief. From this time she became better every day, and in six weeks was able to walk. She had afterwards three children, with which her labours were easy, and she never had any return of the above mentioned complaints.

From all this it is evident, that Dr Denman differs considerably in his opinion from M. Baudelocque concerning the separation of these bones. According to him, it appears that this separation, though extremely painful, does not seem to be attended with *fatal* consequences; and with regard to the *quantity* of the separation, it must undoubtedly be sometimes much greater than what M. Baudelocque supposes; for Dr Denman brings an instance from the 484th number of the Philosophical Transactions, in which the bones were separated to the distance of *four inches*. This happened in consequence of the starting of a horse when a gentleman was riding. He observes, however, that, in women, the violence which the connecting parts of the bones undergo when the head of the child is protruded through the pelvis with extreme difficulty, sometimes occasions an affection of more consequence than even the separation of the bones themselves. This is the formation of matter upon the loosened surfaces of the bones, preceded by great pain, and other symptoms of inflammation.

In the beginning of this complaint, it is difficult to ascertain whether the connecting parts of the bones, or some of those contiguous, be the seat of the disease; but when suppuration has taken place in consequence of the injury sustained at the junction of the ossa innominata with the sacrum, the abscess has sometimes been cured by the common treatment, having formed in the neighbourhood of the injured part. At other times, when matter has been formed about the symphysis of the os pubis, hectic symptoms have ensued, and the cause of them only discovered after the patient died. In some cases the matter has burst through the capsular ligament of the symphysis at the inferior edge, or perhaps made its way into the bladder; and in

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in others it has insinuated itself under the *periosteum*, continuing its course along the pubes, until it arrives at the acetabulum. Thus all the symptoms were aggravated; and the matter making its way towards the surface, a large abscess has been formed on the inner or fore-part of the thigh, or near the hip; so that the patients have at last sunk under the fever and profuse discharge from the ulcer. On dissecting those who have died in this manner, the track of the matter has been followed from the aperture of the abscess to the symphysis, the cartilages of which were found to be eroded, the bones carious, and the adjacent parts very much injured or destroyed. Our author imagines it possible, by means of some particular symptom, to discover whether or not there be any disposition in the parts above mentioned to suppurate, or to know when suppuration has taken place. In all cases of unusual pain attended with equivocal symptoms, the parts ought to be examined with great care and attention: for where there is any disposition to suppurate, it might perhaps be removed by proper means; and when the matter is formed, if there be a swelling in the symphysis, and, more especially, if a fluctuation could be perceived, the propriety of making an incision to evacuate the matter, and prevent farther bad consequences, might be determined.

With regard to the possibility of re-uniting the bones of the pelvis after they have once been separated, our author has the following observations.

“When the connection of the bones of the pelvis has either been impaired or destroyed, it is probable that a confirmation or re-union may take place by a restoration of the original mode, by a callus, or by ankylosis. But it is likewise possible that the bones may remain in a state of separation, and an articulation be formed by the ends of each bone, at the symphysis of the ossa pubis, and at the junction of the ossa innominata with the os sacrum.” Of this last the Doctor has seen one instance in a dead body, and has had reason to suspect the existence of it in some living persons. In the lower degrees of imperfection the former method of union probably takes place; as the complaints made by women of pain and weakness, after delivery, generally go off before their month of confinement is elapsed; but when they continue for a longer time, the best method is to enjoin the patient rest and an horizontal posture. In an increased degree of the complaint, where the health of the patient is affected, a longer time will be required for the recovery; but should the injury be too great to admit of the restoration of the original mode of union, a much longer time will be requisite for the formation of a callus, if this ever takes place except as a previous step to an ankylosis. This last has been observed frequently to take place at the junction of the ossa innominata with the sacrum, but never at the symphysis of the pubes. In this case little can be expected excepting from such remedies as tend to restore the constitution to its pristine vigour; and in the first case above related, the only thing from which the patient seemed to obtain relief was the cold-bath. She was likewise much assisted by the use of a swath, or broad belt, made of soft leather, quilted, and buckled with such firmness over the lower part of the body as to lessen, if not prevent, the motion of the

bones; and this was kept in its situation by a bandage passed between the legs, from the hind to the fore part of the belt. But when a joint is formed between the separated surfaces of the bones, all hope of recovering the patient to her former health may be given up. The only thing which can then be done for her relief must be by the use of a belt, or some similar contrivance, to substitute, as much as possible, artificial firmness, instead of natural. Dr Denman saw one case in which he suspected this to have happened, and in which the life of the patient was truly miserable: He is of opinion, however, that it very rarely occurs; having been informed of another person, who, after eight years confinement to her bed, in consequence of the separation of the bones in the time of labour, was at last restored to the perfect use of her inferior extremities. Instances also, though rare, have occurred, in which women, after labours, have suffered much pain in the region of the sacrum, and totally lost the power of moving their inferior extremities.—This has been supposed a paralytic affection, and they are said to be bed-ridden; but as these patients have generally been restored, though after a very long confinement, our author thinks it reasonable to suppose that their infirmity had been occasioned by a separation of the bones, which at different periods after the accident, according to the degree of their separation, had recovered their former connection and strength.

CHAP. II. Of Pregnancy.

At the time of conception, and for some time after, the parts which form the small fœtus are so blended together, that one cannot be distinguished from another. The whole mass is then called an *ovum*. This ovum consists of four membranes; the placenta, or after-birth; the funis umbilicalis or navel-string, leading to the child; and the surrounding watery fluid in which it floats. Before the child acquires a distinct and regular form, it is called *embryo*, and afterwards retains the name of *fœtus* till its birth. For the increase and nutrition of the fœtus, see ANATOMY, n^o 109. 110.

During the progress of impregnation the uterus suffers considerable changes; but, though it enlarges as the ovum increases, yet, in regard to its contents, it is never full; for, in early gestation, these are confined to the fundus only: and though the capacity of the uterus increases, yet it is not mechanically stretched, for the thickness of its sides do not diminish; there is a proportional increase of the quantity of fluids, and therefore pretty much the same thickness remains as before impregnation.

The gravid uterus is of different sizes in different women; and must vary according to the bulk of the fœtus and involucra. The situation will also vary according to the increase of its contents and the position of the body. For the first two or three months, the cavity of the fundus is triangular, as before impregnation; but as the uterus stretches, it gradually acquires a more rounded form. In general, the uterus never rises directly upwards, but inclines a little obliquely, most commonly to the right side; its position is never, however, so oblique as to prove the sole cause

Pregnancy. cause either of preventing or retarding delivery: its increase of bulk does not seem to arise merely from distention, but to depend on the same cause as the extension of the skin in a growing child. This is proved from some late instances of extra-uterine fœtuses, where the uterus, though there were no contents, was nearly of the same size, from the additional quantity of nourishment transmitted, as if the ovum had been contained within its cavity.

The internal surface, which is generally pretty smooth, except where the placenta adheres, is lined with a tender efflorescence of the uterus, which, after delivery, appears as if torn, and is thrown off with the cleanings. This is the *membrana decidua* of Dr Hunter.

Though the uterus, from the moment of conception, is gradually distended, by which considerable changes are occasioned, it is very difficult to judge of pregnancy from appearances in the early months. For the first three months the os tincæ feels smooth and even, and its orifice as small as in the virgin state. When any difference can be perceived, about the fourth or fifth month from the descent of the fundus through the pelvis, the tubercle or projecting part of the os tincæ will seem larger, longer, and more expanded; but, after this period, it shortens, particularly at its fore-parts and sides, and its orifice or labia begin to separate, so as to have its conical appearance destroyed. The cervix, which in the early months is nearly shut, now begins to stretch and to be distended to the os tincæ; but during the whole term of utero-gestation, the mouth of the uterus is strongly cemented with a ropy mucus, which lines it and the cervix, and begins to be discharged on the approach of labour. In the last week, when the cervix uteri is completely distended, the uterine orifice begins to form an elliptical tube, instead of a fissure, or to assume the appearance of a ring on a large globe; and often at this time, especially in pendulous bellies, disappears entirely, so as to be out of the reach of the finger in touching. Hence the os uteri is not in the direction of the axis of the womb, as has generally been supposed.

About the fourth, or between the fourth and fifth month, the fundus uteri begins to rise above the pubes or brim of the pelvis, and its cervix to be distended nearly one third. In the fifth month the belly swells like a ball, with the skin tense, the fundus about half way between the pubes and navel, and the neck one half distended. After the sixth month the greatest part of the cervix uteri dilates, so as to make almost one cavity with the fundus. In the seventh month the fundus advances as far as the umbilicus. In the eighth it reaches mid-way between the navel and scrobiculus cordis; and in the ninth to the scrobiculus itself, the neck then being entirely distended, which, with the os tincæ, become the weakest part of the uterus. Thus at full time the uterus occupies all the umbilical and hypogastric regions; its shape is almost pyriform, that is, more rounded above than below, and having a stricture on that part which is surrounded by the brim of the pelvis.

The appendages of the uterus suffer very little change during pregnancy, except the ligamenta lata,

which diminish in breadth as the uterus enlarges, and at full time are almost entirely obliterated.

The most remarkable change happens in the ovary. A cicatrice of a roundish figure and yellowish colour appears in this body, called by anatomists the *corpus luteum*. It is always to be found in one of the ovaria; and in cases of twins a corpus luteum often appears in both ovaria. It was formerly considered as the calyx ovi; but modern physiologists think it a gland, from whence the seminal fluid is ejected. In early gestation it is most conspicuous, when a cavity is observable, which afterwards collapses; no vessels appear at the centre of this cavity which has the appearance of cicatrix, but all around that centre the substance is vascular.

During the progress of distension, the substance of the uterus becomes much looser, of a softer texture, and more vascular than before conception; its veins particularly, in their diameters, being enlarged in such a manner as to get the name of *sinuses*; they observe a more direct course than the arteries, which run in a serpentine manner, anastomosing with one another and through its whole substance, especially where the placenta adheres, where this vascular appearance is most conspicuous.

The arteries pass from the uterus through the decidua, and open into the substance of the placenta in a slanting direction. The veins also open into the placenta, and by injecting these veins from the uterus with wax, the whole spongy or cellular part of the placenta will be filled.

The muscular structure of the gravid uterus is extremely difficult to be shown: in the wombs of women who die in labour, or soon after delivery, fibres running in various directions are observable more or less circular, that seem to arise from three distinct origins; viz. from the place where the placenta adheres, and from the aperture or orifice of each of the tubes; but it is almost impossible to demonstrate regular plans of fibres, continued any length without interruption.

CHAP. III. *Spurious Gravidity.*

THE various diseases incident to the uterine system, and other morbid affections of the abdominal viscera, will frequently excite the symptoms and assume the appearance of utero-gestation. Complaints arising from a simple obstruction are sometimes mistaken for those of breeding; when a tumor about the region of the uterus is also formed, and gradually becomes more and more bulky, the symptoms it occasions are so strongly marked, and the resemblance to pregnancy so very striking, that the ignorant patient is often deceived, and even the experienced physician imposed on.

Scirrhus, polypous, or sarcomatous tumors in or about the uterus or pelvis; dropsy or ventosity of the uterus or tubes; steatoma or dropsy of the ovaria, and ventral conception, are the common causes of such fallacious appearances. In many of these cases the menses disappear; nausea, retchings, and other symptoms of breeding, ensue; flatus in the bowels will be mistaken for the motion of the child; and in the advanced

Spurious Gravidity.

vanced stages of the disease, from the pressure of the swelling on the adjacent parts. Tumefaction and hardness of the mammæ supervene, and sometimes a viscid or serous fluid distils from the nipple; circumstances that strongly confirm the woman in her opinion, till time or the dreadful consequences that often ensue at last convince her of her fatal mistake.

False Conception.—Mola. Other kinds of spurious gravidity, less hazardous in their nature than any of the preceding, may under this head also be classed; diseases commonly known by the names of *false conception* and *mola*: The former of these is nothing more than the dissolution of the fœtus in the early months; the placenta is afterwards retained in the uterus, and from the addition of coagula, or in consequence of disease, is excluded in an indurated or enlarged state; when it remained for months or longer, and came off in the form of a fleshy or scirrhous-like mass, without having any cavity in the centre, it was formerly distinguished by the name of *mola*.

Mere coagula of blood, retained in the uterus after delivery, or after immoderate floodings at any period of life, and squeezed, by the pressure of the uterus, into a fibrous or compact form, constitute another species of *mola*, that more frequently occurs than any of the former. These, though they may assume the appearances of gravidity, are generally, however, expelled spontaneously, and are seldom followed with dangerous consequences.

CHAP. IV. *Superfœtation.*

SOON after impregnation takes place, the cervix uteri becomes entirely shut up by means of a thick viscid gluten: the internal cavity is also lined by the external membrane of the ovum, which attaches itself to the whole internal surface of the fundus uteri: the Fallopian tubes also become flaccid; and are, as gravidity advances, supposed to be removed at such a distance, that they cannot reach the ovaria to receive or convey another ovum into the uterus. For these, and other reasons, the doctrine of *superfœtation* is now pretty generally exploded.—A doctrine that seems to have arisen from the case of a double or triple conception, where, some time after their formation in utero, one fœtus has been expelled, and another has remained; or after the extinction of life at an early period, one or more may be still retained, and thrown off in a small and putrid state, after the birth of a full-grown child.

The uterus of brutes is divided into different cells; and their ova do not attach themselves to the uterus so early as in the human subject, but are supposed to receive their nourishment for some time by absorption. Hence the os uteri does not close immediately after conception; for a bitch will admit a variety of dogs while she is in season, and will bring forth puppies of these different species: thus it is common for a greyhound to have, in the same litter, one of the greyhound kind, a pointer, and a third, or more, different from both: Another circumstance that has given rise to *superfœtation* in the human subject, which can only happen when there is a double set of parts, instances of which are very rare.

CHAP. V. *Extra uterine Fœtuses, or ventral Conception.*

THE impregnated ovum, or rudiments of the fœtus, is not always received from the ovarium by the tuba Fallopiana, to be thence conveyed into the cavity of the uterus; for there are instances where the fœtus sometimes remains in the ovarium, and sometimes even in the tube; or where it drops out of the ovarium, misses the tubes, and falls into the cavity of the abdomen, takes root in the neighbouring parts, and is thereby nourished: But as these fœtuses cannot there receive so much nourishment as in the succulent uterus, they are less, and generally come to their full growth before the common term.

Of these some burst in the abdomen; and others form abscesses, and are thereby discharged; others dry, and appear bony, and remain during life, or are discharged as above, or by stool, &c.

CHAP. VI. *Monsters.*

WHEN two or more ova contained in the uterus attach themselves so near one another as to adhere in whole or in part, so as to form only one body with membranes and water in common, this body will form a confused irregular mass called *monstrous*; and thus a monster may be either defective in its organic parts, or be supplied with a supernumerary set of parts derived from another ovum. This seems a rational conjecture; but while every thing relative to generation is a mystery, how can we account for the extraordinary phenomena? Some authors enumerate a third species of monster, the product of a mixed breed, exemplified, for instance, in the mule, produced by the mixed generation of an ass and a mare. In this animal there are organical parts different from what pre-existed in the parents; there is a defect of some parts, a luxuriant growth of others; and the defect in the parts of generation, which renders the animal unfit for propagation, constitutes a very curious and particular species.

CHAP. VII. *Diseases of Pregnancy.*

AFTER conception, a remarkable change is soon produced in the genital system. This is the source from whence arise different symptoms, that are however liable to considerable variation, not only in the constitution of different women, but in the same woman in different pregnancies, and at different periods of the same pregnancy.

Pregnancy,—though a natural alteration of the animal-œconomy, which every female seems originally formed to undergo, and hence not to be considered as a state of disease, occasions, however, sooner or later, in many women, various complaints, which evidently depend on it as a cause.

Diseases incident to the pregnant state may be considered, either, 1. As arising from sympathy in the early months; or, 2. As depending on the stretching and pressure of the uterus towards the more advanced stages.

I. Though

*Outlines of
Midwifery,
by Dr Ha-
milton.*

Diseases of
Pregnancy.

I. Though the former of these complaints are generally to be accounted for from other causes than that of plethora; yet, in many constitutions, a certain plethoric disposition in the early months of pregnancy seems to prevail in the vascular system: And therefore, though many inconveniences may ensue from a too frequent, a too copious, or an indiscriminate use of venesection; yet, if prudently and judiciously employed, abortion by this means will not be endangered, as some late authors have alleged; but, on the contrary, on many occasions, a seasonable bleeding will be attended with the most beneficial and salutary effects.

In young women, suddenly affected with severe sickness and loathing, febrile commotion, headach, vertigo, and other symptoms of breeding, more especially in full sanguineous habits, besides a spare light diet and suitable exercise, recourse must be had to proper evacuations, the chief of which is venesection: this may be safely performed at any time of gravitation, and occasionally repeated according to the urgency of the symptoms; small bleedings, at proper intervals, are preferable to copious evacuations, which in early pregnancy ought always to be carefully guarded against.

When the stomach is loaded with putrid bile or acrid saburra, the offensive matter should be discharged by gentle vomits of ipecacuan, or of infusions of chamomile flowers. The violent efforts to retch and vomit, and the commotions thence excited, which often occasion the expulsion of the foetus, will by this means frequently be removed, in most cases greatly diminished. During the term of breeding, the state of the belly must be also attended to. When laxative medicines become necessary, those of the mildest and gentlest kind should be administered.

In women liable to nervous complaints, where the stomach is weak, and the sickness violent and continued, the patient should be put on a course of light, aromatic, and strengthening bitters; such as infusions of bark, columbo, &c. and her diet, air, exercise, company, and amusement, should be regulated: In order to settle the stomach, and lessen the sensibility of the system, opiates will often happily succeed, when every other remedy fails.

Heart-burn and diarrhoea,—common symptoms of breeding, or of pregnancy, must be treated pretty much as at other times. Both complaints chiefly depend on the state of the stomach.

Tumefaction, tension, and pains in the mammae.—If tight lacing here be only avoided, and the breasts have room to enlarge and swell, no inconvenience ever follows: These effects arise from a natural cause, and seldom require medical treatment. If very troublesome and uneasy, bathing with oil, or anointing with pomatum, and covering with soft flannel or fur, will in most cases prove the cure.

The *menstrual evacuation*—is in some women regular for the first, second, or third period after conception. This seldom happens but in women of sanguinary plethoric habits, such as have been accustomed to large copious evacuations at other times, when the discharge is to be considered as beneficial.

Deliquia, nervous, or hysterical fits—When these are

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occasioned by falls, frights, and passions of the mind, they frequently end in the loss of the child: But when they happen about the term of quickening, they seem to arise from the escape of the uterus from its confinement within the capacity of the pelvis; in which case they are commonly slight, of short duration, and never threaten any dangerous consequence.

II. The second class of complaints, viz. those that are incident to the advanced stages of utero-gestation, and that depend on the change of situation of the gravid uterus, its enlargement and pressure on the neighbouring parts are more painful in their symptoms, and more dangerous in their consequences, than those enumerated in the preceding class. The premature exclusion of the foetus is generally the worst inconvenience resulting from the *one*; the death of the mother, along with the loss of the child, is too frequently an attendant of the *other*.

Difficulty or suppression of urine—is sometimes occasioned by the pressure of the uterus on the neck of the bladder, before the fundus uteri escapes from its confinement within the brim of the pelvis. This complaint, if early attended to, will seldom prove troublesome or hazardous; but cannot be entirely removed till the uterus rises above the brim of the pelvis, and by its enlargement becomes supported by resting on the expanded bones of the ossa ilia. But if neglected in the beginning,

A retroversion of the uterus—is generally the consequence; a case that demands particular attention.—Here the fundus uteri, instead of being loose, falls back in a reclined state within the hollow of the os sacrum: thus a tumor is formed in the vulva, whereof the os tinæ makes the superior part; the body of the uterus, by this means, becomes strongly wedged between the rectum and bladder; and, from the enlargement of the uterus itself, and accumulating load of faeces and urine, the reduction will prove in many instances utterly impracticable. A total suppression of urine, or a rupture of the coats of the bladder, fever, inflammation, or gangrene of the uterus, often ensue; and these are succeeded by delirium, convulsions, death.

The indications of cure, in this dangerous disease, are sufficiently obvious: For, in the first place, every obstacle that prevents the reduction should be removed: thus the contents of the rectum and bladder must, if possible, be evacuated; emollient fomentations and cataplasms must be applied, if indicated by inflammation or tumefaction of the parts. Secondly, The reduction of the prolapsed uterus must be attempted, by placing the patient upon her knees, with her head low and properly supported. While this is attempted within the vagina, a finger or two should also be passed within the rectum, by which the operation in some cases may be facilitated: but, at other times, no power whatever will be sufficient for this purpose. Lastly, If the reduction be accomplished, the fever, inflammatory symptoms, and other consequences of the disease, must be subdued; and a recurrence prevented by an open belly, rest, and recumbent posture, and promoting a free discharge of urine: means that ought to be persisted in till the uterus rises within the abdomen, when the patient will be secured from future danger.

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*Costiveness*Diseases of
Pregnancy.

Diseases of
Pregnancy.

Costiveness in pregnancy—is inconvenient. It may proceed from the same cause with the preceding complaint; it may depend on the stomach; the febrile heat, that in many women prevails, will also prove an occasional cause. It may be obviated or prevented by a proper regulation of the regimen, and by such gentle laxative medicines as are best suited to the state of the woman; the chief of which are ripe fruit, magnesia, lenitive electuary, cream of tartar, sulphureous and aloetic medicines, oleum ricini, emollient glysters.

The piles—frequently arise in consequence of costiveness, or from pressure of the gravid uterus on the hæmorrhoidal veins. These are also to be removed or palliated by the same means employed on other occasions; regard being had to this distinction, which may be applied universally to the gravid state, that all violent remedies are to be avoided: a light diet should be enjoined; the belly should be kept moderately open; and topical liniments or cataplasms should be applied, such as Bals. sulphur. Bals. traumaticum, Liniment. ex ol. palmæ, Ung. sambucin. cum laud. liquid. Poultices of bread and milk with opium, &c. according to the various circumstances of the case.

Oedematous swellings of the legs and labia,—are occasioned by the languid state of the circulation, by the interruption of the reflux blood from the pressure of the distended uterus on the vena cava, &c. These, though very troublesome and inconvenient, are seldom however of dangerous consequence, except where the habit is otherwise diseased; and seldom require puncture, as the swelling generally subsides very quickly after delivery. They can only, therefore, at this time, admit of palliation; for which purpose, along with a proper diet and moderate exercise, a frequent recumbent posture, open belly, and dry frictions applied to the legs evening and morning, will prove the most effectual means.

Varicous swellings in the legs and thighs—from the interruption of the venal blood in these parts, occasioned by the pressure of the gravid uterus, are to be treated in the same manner with the preceding complaint.

Pains in the back, loins, cholic-pains, cramp,—occasioned by the stretching of the uterus and appendages, and from the pressure of the uterus on the neighbouring parts, symptoms that are most troublesome in a first pregnancy, are to be palliated by venesection, an open belly, and light spare diet. If the patient be of a full habit, and pre-disposed to inflammatory complaints, where the pressure is very great in the advanced months, or in twins, &c. if proper remedies are neglected, inflammation of the uterus and adjacent viscera, or dreadful epileptic fits, may quickly ensue; the event whereof is generally fatal. Crampish spasms in the belly and legs require the same palliative treatment; to which may be added friction, and the application of æther, ol. volatil. bals. anodyn. or the like, to the parts affected.

Cough, dyspnœa, vomitings, difficulty or incontinency of urine, occasioned by the pressure of the bulky uterus on the stomach, liver, diaphragm, &c.—Complaints that can only be alleviated by frequent small bleedings, a light spare diet, and open belly. The patient should be placed in an easy posture, something between sitting and lying; and when the uterus rises high, a moderate degree of pressure from the superior part downwards, may in some cases prove useful. But this must be used

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with great caution: for dreadful are the effects of violent pressure, or tight lacing, during pregnancy. It frequently kills both mother and child, and ought to be guarded from the earliest months.

Epileptic fits,—are a very dreadful and alarming appearance. They generally depend on the same cause with the above complaints: they may also arise from irritation, excited by the motion and stirring of the fœtus; and from various other causes. Such as have had convulsions when young, are most liable to have them during pregnancy: they happen most frequently in first pregnancies, or where the fœtus is very large, or in twins, triplets, &c. In such cases, the distention of the uterine fibres is so great, that actual laceration is sometimes the consequence.

At whatever period of pregnancy they seize, the utmost danger may be dreaded. This, however, will be in proportion to the severity, duration, and recurrence of the paroxysm, to the term of gravitation, to the constitution of the patient, and her condition during the remission. The danger is greater towards the latter end of pregnancy than in the earlier months or in time of labour.

Such as arise from inanition, from excessive and profuse hemorrhagies, from violent blows, falls, &c. or from a ruptured uterus, are for the most part fatal.

Hysteric or nervous spasms must be carefully distinguished from true epileptic fits. The former are milder than the latter; they are not attended with foamings; they do not affect the posture; the pulse is smaller, feebler, and more frequent; the woman is pretty hearty after they are over; they are followed with no bad consequences, and yield to the common treatment. Women of strong, robust, vigorous constitutions, are more generally the subjects of the one; the delicate, the nervous, and the irritable, of the other.

Epileptic fits generally come on very rapidly; if any previous symptoms occur, the fit is commonly announced by an intense pain in the scrobiculum cordis, or violent head-ach.

In the pregnant state, these fits are for the most part symptomatic, and will therefore only admit of a palliative cure. They may be distinguished into three classes; those of the early months, those of the latter, and those that come on with labour-pains.

With regard to the cure, the term of pregnancy, as well as the constitution of the patient, and particular cause of the disease, must carefully be considered.

1. Convulsions at an early period of pregnancy chiefly happen to young women of a plethoric sanguine habit; and can therefore only be removed or palliated by a free and bold use of the lancet, by an open belly, cool regimen, and spare diet. After plentiful evacuations, if the stomach be loaded with acrid saburra or putrid bile, a gentle puke may be of use: but such remedies, on those occasions, must be employed with great caution. Instead of a plethoric, if the patient is of a nervous habit, a very necessary and important distinction, the intentions of cure will essentially vary. For here opiates in large doses and frequently repeated, emollient glysters, stupes applied to the legs, the semicupium, and every other means to soothe the nerves and remove spasmodic stricture, will prove the most effectual remedies. If insensible

Diseases. or comatous, opium, musk, and other antispasmodics, should be exhibited by way of glyster, and the patient ought to be roused by epispastic and stimulating cataplasms applied to the legs and hams. Convulsions succeeding profuse evacuations are generally mortal. The *vis vitæ*, in such circumstances, must be supported, by replenishing the vessels with the utmost speed: this is to be done by pouring in nourishing fluids as fast as possible by the mouth and by glyster; warm applications should also be made to the stomach and feet, and nervous cordials given internally along with opium.

The treatment of epileptic fits, depending on other causes than those now mentioned, must be regulated by a proper attention to the particular symptoms with which they are attended.

2. In the advanced months, such complaints are more to be dreaded than in early gestation, as they generally proceed from the irritation occasioned by the distention of the uterine fibres, or by the pressure of the uterus on the contiguous viscera: hence the natural functions of these parts will be interrupted, the circulation of their fluids will be impeded, and the blood, being thus prevented from descending to the inferior parts, will be derived in greater proportion to the brain, and overcharge that organ.

The cure must, in this case, chiefly rest on copious and repeated bleedings, an open belly, and spare diet.

3. Lastly, when fits come on with labour-pains, a speedy delivery, if it can be done with safety, either by turning the child, or by extracting with the forceps when the head is within reach, will prove the most effectual cure.

When the bladder is distended, the contents must be evacuated: if a stone sticks in the urethra, it must be pushed back or extracted. If the fits are the effects of a ruptured uterus, immediate death is generally the consequence.

With regard to the treatment of such complaints, no other change is generally requisite, than what arises from the symptoms peculiar to this situation. In general, till after delivery, they will only admit of palliation.

CHAP. VIII. *Floodings.*

THESE, though confined to no particular term, may happen at every period of gravitation. The one is a frequent consequence of the other; the event of both is often hazardous, as the earlier miscarriages are generally preceded by an effusion of blood from the uterus, which, in the advanced stages of pregnancy, besides the loss of the child, always endangers the life of the mother.

The *menorrhagia gravidarum*—may be defined, an effusion of blood from the uterus, confined to no regular or stated periods, in quantity and duration various, and liable to recur on the slightest occasions.

The immediate cause is, a separation of some portion of the placenta or chorion from the internal surface of the uterus. Whatever occasions this separation may be considered as the remote cause, which, though various, may be reduced to

I. Those that affect the general system: as,

1. External accidents changing the state of the circulation.
2. Changes in the circulation from internal causes.
3. Debility.
4. Plethora.

II. Those that affect the uterus and placenta: as,

1. Direct affections.
2. Stimuli communicated from an affection of other parts.

With regard to the cure.—Though a flooding in some constitutions may happen, even in early gestation, and may remit and recur from time to time, and the woman go on to the end of her reckoning; and tho' it seldom or never happens that this complaint proves mortal to the mother in the first five weeks of pregnancy; yet every appearance of this kind, even the slightest, is to be dreaded; as in the early months it will often throw off the foetus, and, in the latter, always threatens the utmost danger both to mother and child. Floodings of gravid women we cannot propose radically to cure; they will only admit of palliation. With this view, the indications are,

I. To lessen the force and velocity of the blood in general.

II. To promote the constriction of the patulous mouths of the bleeding vessels, or the formation of coagula in their orifices.

1. To answer the first indication, rest and a recumbent posture, cool air, tranquillity of mind, a light diet, venesection, and opiates, are the chief means.

2. To restrain the violence of the hemorrhagy, internal astringent medicines are recommended; but this is to be accomplished chiefly by means of cold styptic applications to the parts and their neighbourhood. But as these floodings often arise from so various and opposite causes, it is difficult to lay down particular indications, or to point out a method of cure suited to every case that may occur. The intention of cure can only be regulated by a careful and judicious consideration of the cause, and of those particular circumstances with which the case may be attended. In early pregnancy, it may be restrained by keeping the patient quiet and cool, by giving internally cooling things and opiates; but, in the advanced stages, the deluge is sometimes so profuse as to kill very suddenly. Under such circumstances, when the woman is near her time, emptying the uterus by delivery, if practicable, is the only safe expedient both for preserving the life of the mother and of the child.

If the hemorrhagy can be restrained, a recurrence must be guarded against, by avoiding or counteracting the occasional or remote causes.

CHAP. IX. *Abortion, or Miscarriage,*

MAY be defined, the premature expulsion of the embryo or foetus. Some, however, make the following distinction: When a woman miscarries in early gestation, this they consider as an abortion; but if in the latter months, that they term a *premature birth*. The symptoms that threaten abortion are:

Flooding.

Pain

Abortion.

Pain in the back and belly.

Bearing down pains with regular intermissions.

The evacuation of the waters.

The death of the child, which discovers itself by the following symptoms; though in general these are so doubtful and fallacious, that none of them afford an infallible sign:

1. The subsiding of the abdominal tumor.
2. Cessation of motion in the foetus.
3. The sensation of a heavy weight falling from side to side, as the woman turns herself in bed.
4. Sickness, faintings, rigors, cold sweats.
5. The breasts turning flaccid.
6. Coldness of the abdomen, and putrid discharge from the vagina.

Abortions are seldom dangerous in the first five months; but a frequent habit of miscarriage debilitates the system, shatters the constitution, and lays the foundation of chronic diseases of the most obstinate and dangerous nature.

In the advanced months, the prognosis will be more or less favourable according to the patient's former state of health, the occasional cause, and symptoms with which it is attended. The proximate cause of abortion is the same with that of true labour, viz. a contracting effort of the uterus and abdominal muscles, assisted by the other expulsive powers. The remote causes cannot be explained with precision; as many circumstances, with regard to the nature of impregnation, and connection of the foetus with the placenta and uterus, are subjects still involved in darkness. They may in general, however, be reduced,

- I. To whatever interrupts the regular circulation between the uterus and placenta.
- II. To every cause that excites the spasmodic contraction of the uterus, or other assisting powers.
- III. To whatever occasions the extinction of life in the foetus.

Amongst the first are:

1. Diseases of the uterus.
2. Imperviousness or spasmodic constriction of the extremities of the uterine blood-vessels.
3. Partial or total separation of the placenta or chorion from the uterus.
4. Determination to other parts.

To the second general head belong all causes that produce a strong contraction of the elastic fibres of the uterus, or of the parts that can press upon it, or that occasion a rupture of the membranes: such as,

1. Violent agitation of mind or body.
2. A disease of the membranes.
3. Too large a quantity of liquor amnii.
4. The cross position of the foetus.
5. Its motion and kicking.

The last head includes the numerous causes of the death of the child, which, besides those referred to in the preceding classes, may be occasioned by,

1. Diseases peculiar to itself.
2. Diseases communicated by the parents.
3. External accidents happening to the mother: or,
4. Accidents incident to the foetus in utero.
5. Diseases of placenta or funis.
6. Knots and circunvolutions of the chord.
7. Too weak an adhesion of placenta or chorion to the uterus: and,

8. Every force that tends to weaken or destroy this attachment. Regimen.

With regard to the treatment. This must be varied according to the particular circumstances of the case: nor is it possible to point out particular indications, or propose any regular plan to be pursued for this purpose. Abortion is often preceded by no apparent symptom, till the rupture of the membranes, and evacuation of the waters, announce the approaching expulsion of the foetus. Either to remove threatening symptoms, or to prevent miscarriage when there is reason to apprehend it, often baffles our utmost skill; because it generally happens, that there is a cessation of growth in the ovum; or, in other words, an extinction of life in the foetus, some time previous to any appearance of abortion. For instance, in early gestation, a woman commonly miscarries about the 11th or 12th week; but the age of the foetus at this time is generally no more than eight weeks. At other times, when by accident the foetus perishes, perhaps about the fifth or sixth month, it will still be retained in utero, and the expulsion will not happen till near the completion of full time.

As women who have once absorbed are so liable to a recurrence from a like cause, at the same particular period, such an accident, in future pregnancies, should therefore be guarded against with the utmost caution. On the first appearance of threatening symptoms, the patient should be confined to a horizontal posture; her diet should be light and cooling; her mind should be kept as tranquil as possible; a little blood from the arm may be taken occasionally; and opiates administered according to circumstances: but excepting so far as depends on these, and such like precautions, for the most part, in the way of medicine, very little can be done.

Manual assistance is seldom or never necessary during the first five months of pregnancy: the exclusion of foetus and placenta should very generally be trusted to nature.

The medical treatment of abortion must therefore be considered with a view only to the prophylactic cure, and this again will chiefly consist in a proper

CHAP. X. *Regimen during Pregnancy.*

WOMEN, when pregnant, should live a regular temperate life; moderation in eating and drinking should now be very carefully observed, and every thing that has any tendency to disagree with the stomach should be avoided; otherwise the manner of life should be much as usual. If complaints do occur, these should be treated as at other times; only guarding against such things as, by violent operation, may endanger miscarriage. If the woman has formerly been subject to this accident, the cause should be carefully considered, and suitable remedies applied; if plethoric, for instance, she should be bled, live sparingly, and kept quiet, till she gets beyond the dangerous period. If she be weak, delicate, and nervous, bark, light aromatic bitters, mineral waters, and the cold bath (if able to bear it), will prove the best prophylactic remedies. The cold bath has, in many cases, cured the most obstinate fluor albus, and sometimes even sterility itself; and, in relaxed habits disposed to miscarriage, when every other

Regimen. means has failed, the cold bath has done considerable service: the practice may safely be continued for some months after conception, when it has been early begun, or when the patient has been accustomed to it. Such a shock will, however, act very differently on different systems: hence it is an expedient by no means to be indiscriminately used in the pregnant state.

Abortions that happen in early gestation, and that come on suddenly without any presaging sign, if ever they are to be prevented, it can only be done by avoiding all occasional causes, by counteracting morbid dispositions, and by confinement to a horizontal posture, for some time before, and till the critical period be over.

When a venereal taint in the parents is suspected to be the cause either of abortion or the death of the fœtus, the like accident can only be prevented by putting both parties on a mercurial course.

Pregnant women require a free pure air; their amusement should often be varied; their company should be agreeable and cheerful; their exercise should be moderate, and suited to their inclination, constitution, and the season; they should avoid crowds, confinement,

Regimen. travelling over rough roads in a carriage, or being exposed to sea-voyages. Riding a-horseback should also be practised with great caution, that disagreeable objects may be shunned, and shocks of every kind prevented. For this reason, when riding is judged proper, the woman should be a courageous rider; she should never ride without somebody being in company; the horse should be tame and well trained; the road should be smooth as well as private; and the exercise should be gentle and easy, and never carried the length of fatigue. Women should, with the utmost care, guard against confining the breasts or belly; early recourse should be had to jumps, and they should keep themselves as loose and easy as possible through the whole term of utero-gestation. An open belly is necessary and important in the pregnant state; it keeps the stomach in good condition, prevents cholics and other complaints that may terminate in miscarriage. When the abdomen is pendulous towards the latter months, a gentle support by proper bandage will prove useful; and the woman, when fatigued, should occasionally, through the day, indulge in rest on a bed or couch.

PART II. OF LABOURS.

LABOURS are divided into three classes: *natural*, *laborious*, and *preternatural*.

In whatever manner the head of the child presents, where the delivery at full time is performed by nature, the labour is with great propriety called *natural*; when the birth is protracted beyond the usual time, or cannot be accomplished without extraordinary assistance, it is deemed *laborious*; and *preternatural*, when any other part but the head presents.

CHAP. I. *Natural Labour.*

By whatever power the uterus is enlarged, when any further increase is prevented, a stimulus to contraction must ensue; by this means an uneasy sensation is excited, which must, in the woman, produce an effort to procure relief: and thus arise the true labour-pains, which at first are slight and of short duration, a considerable remission intervening: the periods of recurrence soon become more frequent; the pains acquire an increased force, producing more and more change on the os uteri; which, yielding to the impelling cause, gradually opens and expands; till at length it becomes completely dilated, the membranes protruded and ruptured, and the child, by the expulsive force of the uterus, assisted by that of the diaphragm and abdominal muscles, is thus pushed along and delivered.

The symptoms of approaching labour are, The subsiding of the abdominal tumor: hence a discharge of mucus from the vagina, sometimes tinged with blood; incontinency, or suppression of urine; tenesmus; pains of the belly, loins, and about the region of the pubes; restlessness, hot and cold fits, &c.

Spurious pains are to be carefully distinguished from those of genuine labour. The former arise from the stretching of the uterus and its pressure on the neigh-

bouring parts, or from costiveness; and are to be distinguished from the latter by the following symptoms: They are most troublesome towards the evening, increase in the night, and abate through the day; they are more trifling and irregular than true uterine pains; the uterine orifice is not affected; and there is no increased flow of mucus from the parts.

True pains begin about the region of the kidneys, strike forward towards the pubes, and down the thighs: they return at regular periods: there is a copious discharge of mucus from the vagina; the os uteri gradually opens, and can be felt to dilate in time of a pain; while the membranous bag, in a tense state, forcibly pushes against the finger.

The event of labours is so precarious, that no certain judgment can be formed from almost any symptoms, till the labour itself be considerably advanced. A prognosis in general is chiefly to be formed from the age, state of health, and temperament of the patient; from the force, duration, and recurrence of the pains; and from their effect on the uterine orifice; from the time of the rupture of the membranes; from the general make and form of the woman, but, in particular, of that of the pelvis; from the bulk and position of the child, &c.

With regard to the method of delivery, and position of the woman, this has been different at different ages, and in different countries: the chief thing, however, is to guard against cold and fatigue, observing that the woman be placed in the most favourable posture for supporting the back, for the action of the abdominal muscles, &c. and most convenient for the necessary assistants: till the labour is considerably advanced, she may be indulged in whatever posture is most agreeable; after which the bed or couch is the most proper.

With regard to assistance in natural parturition, the accoucheur

Natural
Labour.

accoucheur for the most part has little to do, till the membranes are ruptured, and the head in perinæo. In time of labour, the woman should be kept very cool, and every means of being overheated should be avoided. She should be put to bed in proper time, placed on her side or back, with her head and shoulders a little raised, a cloth tied to the bed-post, or held by an assistant, to support her hands in time of pain, and her feet resting against a foot-board; her knees should be drawn up towards the belly, and a folded pillow put between them. All efforts to press or strain, except what nature excites, are improper, hurtful, and should be avoided: the membranes, if possible, ought not to be ruptured till they almost protrude at the os externum; the perinæum must be lubricated when formed into a tumor, and carefully supported while over-stretched; for this purpose, a cloth smoothly folded should be applied over the part, to enable the accoucheur to have a firmer hold. This is an important part of his office; and must be attended to with the strictest care. From the time this protrusion begins to form till the head of the child be completely delivered, the perinæum must be carefully preserved by the palm of the hand firmly applied against it, which should be carried backwards in a direction towards the anus, and kept so during every pain. Thus the miserable consequences will be prevented to which the neglect of this pressure exposes: for by this support the over-stretching of the perinæum will be greatly lessened, the parts will dilate gently and gradually, the vertex will easily slip from under the pubes, and the fore-head will rise from under the perinæum in a safe, slow, and gentle manner. The perinæum must now be released, by cautiously sliding it over the face and chin of the child; and this ought to be made further sure of, by passing a finger under it round and round. After the head has thus mechanically advanced through the pelvis and vagina, a pain or two must be waited for, when in like manner the body will follow; nothing more being necessary than to support the child while it is gradually pushed forwards by the expulsive force of the natural pains.

When the child has cried, and the change in the circulation freely taken place, the funis umbilicalis must be tied and divided, the infant must be wrapped in a warm receiver, and given to the nurse to be washed and dressed.

The parts of the woman must now be gently wiped, a warm soft cloth must be applied, and a proper time waited for the separation of the placenta.

This is also the work of nature, and seldom requires more force to bring it along than if it lay entirely loose within the cavity of the uterus. Thus, in pulling, no greater force should be employed than is just sufficient to put the funis on the stretch: for if it is already separated, no violence is necessary to extract it; and if the adhesion is very firm, all violent efforts are improper, and often followed with most dangerous consequences. Its advancing is known by the contraction of the uterus, and shifting of the abdominal tumor, and by the lengthening of the cord. By the spontaneous contraction of the uterus, this separation is effected; the expulsion will be slower or more expeditious, according to the state and condition of the woman, according to the number of children she has born,

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Labour.

and according to the duration or violence of the labour; it is easier and sooner separated in a first birth, when the woman is in good health, and when the labour has been properly managed. In most cases, this separation is accomplished within half an hour after the delivery of the child. It adheres most firmly after premature births, when the woman has been sickly during pregnancy, where the labour has been tedious and difficult, or when hasty attempts have been made to extract it. A finger, or finger and thumb, guided by the funis, and introduced within the vagina, to bring down the edge, will remove any difficulty occasioned by the centre or bulky part passing the uterine or vaginal orifice.

When it becomes necessary to employ force in extracting the placenta, which is never requisite but in cases of flooding, when the woman has been in bad health during pregnancy, when she has suffered much in time of labour, or when the string has been torn from it (though the first of these cases is perhaps the only one wherein the practice is absolutely proper), the method of doing it is as follows: In ordinary cases, the woman should be laid on her back or side; but when the belly is pendulous, or when the placenta is attached to the fundus uteri, she must be placed on her knees, which is the most convenient posture.

The accoucheur, though with a certain degree of courage, yet with the utmost possible tenderness, must then pass his hand well lubricated through the vagina into the uterus, and feel for the convex body of the after-birth; if the chord be entire, this will direct him; if not, he must feel for the loose membranes at the edge of the cake, and must not be deceived by coagula of blood that lie in the way; if the uterus be constricted in the middle like a sand-glass, a circumstance that sometimes, though rarely, occurs, this must be overcome by a gradual dilatation with one finger after another, till the whole hand in a conical manner can safely be passed. He must not content himself with feeling a part; he should be able to move his fingers round the whole body of the cake; the adhesion must be separated very gradually, in a direction from the sides round and round. The placenta is distinguished from the uterus, as well by its softness as by its convex puckered feel. This convexity increases in the same proportion as the uterus contracts: hence the middle part or centre of the placenta is first detached; and if the edges are carefully separated, by gently passing the fingers behind, the whole body becomes loose and disengaged, which must now be brought along with great caution, that no part be left behind, and that no injury be done to the woman in making the extraction.

Though bad consequences sometimes follow from the retention of the placenta, yet it is much to be questioned, if these are not less to be dreaded than the dangerous floodings, convulsions, deliquia, inflammation of the uterus, fever, &c. that may be induced from the preposterous practice of passing the hand to make the extraction: and would it not in general be better to confine the practice of introducing the hand, to cases of uterine hemorrhagies only? Where the adhesion is so firm as to require force, or where its place of attachment is out of the reach of the finger, by which, for the most part, the edge may be brought

down.

Difficult
Labour.

down, is it not by far the safest and the most rational practice universally to trust to nature? Should the mouth or body of the uterus become constricted before the separation is effected, no matter; little is to be dreaded: it will afterwards kindly dilate; and the separation and expulsion will spontaneously be accomplished with as much safety as in other animals, where no force is ever used. Let every candid practitioner acknowledge, that for one instance where the retention of the placenta has been attended with dangerous consequences, a precipitate or forcible extraction has proved fatal to hundreds.

After the delivery of child and placenta, the woman must rest a few minutes; her strength and spirits may be recruited by some light nourishing cordial; the wet cloths, &c. must then be removed; the bed must be properly shifted and adjusted; and a gentle compression must be made on the abdomen.

During lying-in, the woman should avoid company and noise; her dress and bed-linens should be often changed; she should avoid every means of being overheated; and with regard to her diet, it should, for the first week at least, be very light and of easy digestion.

CHAP. II. Laborious or difficult Labour.

Hamilton's
Outlines.

WHEN the birth is protracted beyond the ordinary time, or when the child's head, though naturally presenting, cannot be brought forwards without assistance, the labour is accounted difficult or laborious.

Though the causes of laborious births are various and complicated, they may in general be considered as depending,

- I. On the mother.
- II. On the child.
- III. On the secundines.

I. The birth may be protracted, or the labour-pains interrupted, by,

(1.) Debility in the mother, arising,

a From disease, viz.

1. Flooding.
2. Epileptic fits.
3. Crampish spasms.
4. Lowness and faintishness.
5. Inflammatory diathesis.
6. Colic.
7. Nauseating sickness and vomiting.
8. Hectic or consumptive habit.

b From passions of the mind.

c From mismanagement in time of labour.

(2.) Local complaints in the parts, or their neighbourhood, viz.

a In the bones, occasioning narrowness and distortion.

b In the soft parts, viz.

1. Dryness and constriction of the vagina.
2. Thickness and rigidity of the os tincæ.
3. Scirrhus or polypous tumors about these parts
4. Accumulated feces in the intestines.
5. Stone in the urethra.
6. Prolapsus of the uterus, vagina, and rectum.

7. Obliquity of the uterus.

II. Difficulties also arise on the part of the child, viz.

1. From the bulk and ossification of the head.
2. The situation in which the head presents.
3. Large broad shoulders, or their transverse descent through the pelvis.

III. The secundines, viz.

1. The rigidity of the membranes, and the contrary.
2. Too great a quantity of water.
3. The funis umbilicalis too long or too short.
4. The prolapsus of the funis before the child's head: and,
5. The attachment of the placenta towards the cervix or os uteri.

The treatment of laborious births requires a very nice and careful attention to the condition of the patient and other circumstances, from whence only we can judge when assistance becomes requisite, and how it may be applied to the best advantage. That pain and misery is the unavoidable and inseparable attendant of child-bearing, though dealt out in different proportions to different subjects, the testimony of all nations, and all ages, as well as daily experience, bear witness: nor is the easiest labour altogether exempted from pain, even under the most favourable circumstances. The delivery, however, promises to be safe and easy, when the woman is of proper age, in good health, the child presenting right, and the pelvis well proportioned; but the force of the natural pains may be interrupted, and of consequence labour be retarded, from,

I. Debility in the mother, arising from

a Disease. This may appear under various forms; as,

1st, A flooding. Which is very alarming, even along with labour-pains: though less so in this case than when at a distance from full time; because as the labour-pains increase, the hemorrhagy very generally abates: or if not, breaking the membranes when the aperture of the os uteri is sufficient to admit the hand, seldom fails to produce that effect. The woman in this case must be kept cool. Opiates must be administered; she must be comforted with the best assurances of a happy delivery; and the natural pains must be waited for.

But if the hemorrhagy proceeds from a separation of the placenta, attached towards the cervix or orificium uteri; in this unhappy case, the whole body of the cake may be completely separated before the aperture of the uterus be sufficient for allowing the head to pass; and the deluge may be so sudden and impetuous, that the woman will sink immediately under it. Breaking the membranes, and making the delivery, either by turning the child, or extracting with the forceps or crotchet, according to circumstances, with as much expedition as is consistent with the mother's safety, is the only expedient by which the threatening catastrophe may be prevented.

2dly, Epileptic fits may in like manner retard labour, and endanger the life of the mother. If the child is not thrown off by a few fits, which is often the case, the delivery should be effected as soon as possible.

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3dly, Crampish spasms in the thighs, legs, rarely in the belly, are very troublesome. They depend on the pressure of the head on the nerves as it passes through the pelvis, and can only be removed by delivery; which, as these pains are seldom if ever attended with danger, is not to be forced on this account. Breaking the membranes will sometimes remove them.

4thly, Lowness and faintishness often occur, and frequently prove the cause of protracted labour.

No general rules with regard to the management of slow labour can be recommended. The mode of treatment, where so many circumstances may occur, must be suited to the condition of the patient, as every particular case will in some measure require a different management. Much depends on the prudence and judgment of the attentive practitioner. For instance, when the woman is nervous, low-spirited, or weakly, from whatever cause, in general her strength must be supported: she must not be put on labour too early; she must avoid heat, fatigue, and every means of exhausting her strength or spirits. When she is restless, or the pains trifling and unprofitable, opiates are particularly indicated; they remove spurious or grinding pains, recruit the spirits, procure rest, and amuse time. Little else for the most part is to be done. If the uterus once begins to dilate, though the dilatation goes on slowly, it is by much the best and safest practice to do nothing but regulate the management as above. The pains at last will become strong and forcing; and the delivery, even where the patient has been very weakly, will often have a safe and happy termination. In these tedious labours, if the strength of the woman be properly supported, every thing almost is to be expected from nature. Forcible means should be the last resource.

5thly, Inflammatory diathesis, in young subjects of strong rigid fibres and plethoric habits, must be obviated by venesection, an open belly, and cooling regimen.

6thly, Colic.—Many women have severe attacks of this disease immediately before the labour-pains come on; the reason of which is sufficiently obvious: the belly, which formerly rose so high that the fundus of the womb pressed against the pit of the stomach, afterwards subsiding, by the child's sinking to the lower part of the womb, and the oval of the head being applied to the oval of the basin, the contents of the intestines will be forced lower and lower, and the strait gut will be distended. Hence colic-pains, irritation, and uneasiness, a frequent desire to go to stool, or frequent loose stools, generally ensue. The best palliative remedy is to inject emollient glysters repeatedly till the bowels be entirely emptied. Although some degree of purging should attend the tenesmus, it will be necessary to wash the strait gut, by the use of one or more glysters. The irritating cause being in this way removed, an opiate, if no inflammatory heat or fever prevents, may be afterwards given with advantage.

7thly, Nauseating sickness, with vomiting.—When these symptoms occur, warm water or chamomile-tea must be drunk freely. Sickness and vomiting happen in some degree in the easiest labours. Sometimes they proceed from a disordered state of the stomach; but

in general are to be accounted for from the well-known sympathy of the womb with the stomach; and accompany the stretching of the os uteri only.

8thly, Hectic or consumptive habit.—It is a melancholy thing to attend a labouring woman in this state. The pains are weak and trifling; she cannot force much down; and she is feeble, and liable to faint when the pain goes off. But however apparently exhausted, the progress of labour goes on, in most cases, much better than could be well expected. The orifice of the womb gives little resistance to the force of the pains, weak and trifling as they are; the parts are soft and lax, and soon stretch in such a manner, that, if there be no fault in the pelvis, the child readily obtains a passage.

Here little is to be done but supplying the patient from time to time with light nourishment; with cordials that do not heat: and keeping up a free circulation of cool air all around her: for this purpose the curtains should be quite drawn aside, doors and windows widely opened; and she should be placed in a position with her head and breast well raised, that an easy respiration may be promoted. Hectic women under proper management rarely sink immediately after delivery; they generally survive a week or longer, tho' they seldom outlive the month.

b. Passions of the mind. Any piece of news in which the patient, her family, or relations, are interested, should be carefully concealed, as well as every thing that tends in general to affect the passions; as labour may not only be interrupted from this cause, but the most dangerous symptoms, as floodings, convulsions, deliquia, and fatal syncope, may be induced.

c. From mismanagement in time of labour often arises debility; so that the patient's strength is exhausted, the pains at length entirely cease, and the head of the child remains locked in the pelvis, merely from want of force or pain to push it forwards. In all cases where the labour has the appearance of being tedious, the woman's patience must, as much as possible, be supported. During the grinding pains, she must be kept cool and quiet: opiates may be exhibited to pass the time, till the forcing throes ensue, when she will acquire resolution, the parts will dilate kindly, and the labour end happily; whereas, if she considers herself in labour from the earliest appearance of grinding pains, she is frightened at the length of time, and her patience runs out. Slow lingering labours happen chiefly to elderly women having a rigidity in the parts, to nervous subjects, and to such as have been weakly during pregnancy. It is of great consequence, and the advice cannot be too much inculcated, to avoid exhausting the woman's strength too much at first.

2. Local complaints in the parts, or their neighbourhood.

a. Narrowness or distortion of the bones of the pelvis. Where there is any material defect in this cavity, a superficial knowledge of the form and structure of the parts will enable us to judge. If, from the figure of the woman's body, there is reason to suspect a faulty pelvis; if the spine is twisted, the legs crooked, the breast-bone raised, or the chest narrow; whether the pelvis be affected or not, she will require a particular management; for the constitution of such women is

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weak and feeble, and they cannot be much confined to bed on account of their breathing. We can never be absolutely certain of a distortion of the pelvis (except when the distortion is confined to the inferior aperture) till the uterine orifice is considerably dilated. After this time, if the pains are strong and forcible, and the head of the child makes no advance, a narrow pelvis or large head is to be suspected. The pelvis may be faulty at the brim, bottom, or in the cavity or capacity. The first of these, which most frequently occurs, is the most difficult to be discovered. The second can be readily perceived by the touch: for we can feel the defects in the shape of the os sacrum and coccyx, in the position of the ischia, and in the bending of the pubes; and where the distortion is so general, that the whole cavity of the pelvis is affected, the shape of the woman's body, the slow progress of the labour, and the state of the parts to the touch, will afford sufficient information.

In the first case, we can only know the distortion by the symptoms; for we should not attempt to introduce the hand till the mouth of the womb be dilated: it is afterwards unnecessary; for we know that the pelvis is too small, or the head too large, by its not advancing in proportion to the pains, and by feeling a sharp ridge like a sow's back on the top of the child's head, which is occasioned by the bones rising over each other in consequence of the pressure.

How long nature, in such circumstances, can support the conflict, it is difficult to say. It is sufficient to observe, that when things are properly prepared for the advance of the child, when the first stage of the labour is accomplished, but its progress is then suspended, it is of little consequence to the midwife whether the obstacle is to be referred to the child or to the mother; and a man-midwife ought to be immediately called in.

If the patient's strength declines; if the head, from being locked in the bones of the pelvis, begins to swell, and the parts of the woman to be affected with tumefaction and inflammation; nature, in this case, seems insufficient, and it will be dangerous longer to delay the proper means of making the delivery; as mother, or child, or both, may fall a victim to our neglect. We must not, however, allow ourselves to be imposed on, either by the impatience of the distressed mother, or by the clamours of the officious impertinents about her. In affording that assistance we are able to give, we are only to be directed by the symptoms of the case: we must remember, that the gentlest assistance our hands or instruments in laborious births can afford, is always attended with hazard and risk; that if instruments be applied too early, nature will be thus interrupted in her work, and the most fatal consequences may ensue; and that if assistance be delayed too long, the mother may die undelivered: we ought, however, to be informed, that the former practice of having too early recourse to forcible means, where, in time, nature unassisted might do her business, has proved by far more fatal than the latter. We ought therefore carefully to consider the general history of the patient, and particular circumstances of the case, that we may hit the proper time of making the delivery; which, in these laborious labours, is exceedingly diffi-

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cult to determine; yet is a matter of the utmost importance, as there is always one, often two or more lives at stake, and the accoucheur is accountable for the consequences of his misconduct or neglect.

6. The fault may be in the soft parts: as,

1. Dryness and constriction of the vagina. Here all stretching and scooping is to be avoided. The natural moisture is to be supplied by lubricating with pomatum or butter, or by throwing up injections of warm oil; the parts are likewise to be relaxed by the application of warm stupes, or by warm steams directed to them.

2. Thickness and rigidity of the os tincæ. This happens chiefly in women well advanced in life, where the parts open more slowly, and the labour generally proves more tedious. Here also little is to be done but waiting on with patience, comforting the woman as well as possible, and giving an opiate from time to time. The parts may be relaxed with butter or pomatum, by throwing into the vagina injections of warm oil, or by the application of warm stupes to the os externum. Every forcible attempt to open or stretch the uterus, as some authors presume to advise, is apt to induce inflammation and its consequences, and to interrupt the natural pains: it is therefore universally the safest practice to trust in every case to these; though tedious, or even violent, the labour for the most part will end more happily, and the woman recover better, than if force had been employed.

3. Polypous tumors, &c.—There is seldom occasion, in case of cicatrices in the vagina, to dilate with the scalpel, to remove polypous tumors by excision, or to cut upon and extract a stone from the urethra in time of labour. But if circumstances are urgent, such expedients are safe and practicable, and warranted by many precedents.

4. Accumulated feces in the intestines ought always to be removed by repeated emollient glysters on the first appearance of approaching labour.

5. A stone in the urethra, if it cannot be pushed back, must be cut upon and extracted, as already advised.

6. Prolapsus of the uterus may happen even at full time, in a pelvis too wide in all its dimensions; for which, however, nothing can be done but to support the uterus in time of a pain, that the stretching of the parts may be gradual. Prolapsi of the vagina and rectum must be reduced at the remission of the pain, and a return by gentle pressure must be prevented.

7. Obliquity of the uterus, though a favourite theory of some authors, never happens in such a degree as to influence delivery, except in the case of a pendulous abdomen, or where it depends on the make or distortion of the pelvis. The first of these, though it may, by throwing the child's head over the pubes, occasion perhaps some little delay, will seldom prove any material obstacle to the progress of the labour.

II. The protraction of labour may depend on the child, and may arise from,

1st, the bulk or ossification of the head.

There may be either a natural disproportion between the head and body, or the swelling may be occasioned by a putrid emphysema in consequence of the child's death, or the enlargement may proceed from a hydrocephalus.

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cephalus. The first of these cases can only be discovered by the slow progress of the labour, when the pains are strong and frequent, the soft parts sufficiently dilated, the woman in good health, and no other apparent cause to account for the remora. The second is discovered from the history of the case, from the common symptoms of a dead child, *viz.* the puffy emphysematous feel of the presenting part of the head, and from the separation of the cuticle when touched. Lastly, the hydrocephalus is discovered by the head falling down in the pelvis in a large bulky form, by the bones of the head being separated at considerable distances, and by a fluctuation evident to the touch. On the whole, however, it may here be observed, that the most probable or suspicious symptoms of the child's death are often deceitful.

From whatever cause the head is enlarged, if the difficulty arises from this cause, and the force of the pains prove insufficient to push the head forwards, recourse must be had to instruments; and if the bulk of the head is too large to pass the diameter of the pelvis, the cranium must be opened to diminish its size, and the brain evacuated previous to the extraction.

2dly, The position of the head, which may be squeezed into the pelvis in such a manner as not to admit of that compression necessary for its passing. Such a cause of difficulty, however, more seldom occurs than many authors have imagined. The rash and preposterous application of instruments has, in such cases, proved the bane of thousands. Here though the labour will prove more painful and more tedious, yet nature in general, unassisted, will accomplish her own work with more safety to mother and child, than by the intrusion of officious hands. Turning here is always difficult, often dangerous. The same observation will hold of instruments, which should never be employed but when alarming symptoms occur: the assertion perhaps is not more bold than true, that, in general, the most disadvantageous position in which the head can offer is not sufficient, without some other cause concurring, either to prevent delivery, or to endanger the life of mother or child so much as would be done by the movement of the gentlest hands. Yet, in some cases, where the woman is weak and exhausted, and the pains trifling; if the head of the child be large, the bones firm, and the sutures closely connected; or if there be any degree of narrowness in the pelvis, a difficult labour is to be expected; and the life of both mother and child will depend on a well-timed and skilful application of the surgeon's hands.

The unfavourable position of the head may be referred to two kinds, which include a considerable variety. 1. When the fontanella, or open of the head, presents instead of the vertex. 2. Face-cases.

If no other obstacle appears but the presenting of the fontanella, the labour will by proper management generally end well; and much injury may be done by the intrusion of officious hands.

Face-cases are the most difficult and laborious of all kinds of births; and our success in these will chiefly depend upon a prudent management, by carefully supporting the strength of the woman. The varieties of face-cases are known by the direction of the chin; for the face may present, 1. With the chin to the pubes;

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2. To the sacrum; 3. To either side. The rule in all these cases is to allow the labour to go on till the face be protruded as far down as possible. It is often as difficult and hazardous to push back the child, and to bring down the crown or vertex, as to turn the child and deliver it by the feet. Sometimes a skilful artist may succeed in his attempt to alter the position, when he has the management of the delivery from the beginning; or, in those cases where the face is considerably advanced in the pelvis, may be able to give assistance by passing a finger or two in the child's mouth, and pulling down the jaw; which lessens the bulk of the head; or, by pressing on the chin, to bring it under the arch of the pubes; when the crown getting into the hollow of the os sacrum, the head will afterwards pass easily.

3dly, The breadth of the shoulders, or their transverse descent through the pelvis, rarely proves the cause of protracted labour. The head is always pretty far advanced before any obstruction can arise from this cause; and if the head has already passed, in a pain or two the shoulders will follow. The same reasoning will also apply with regard to the aperture of the uterus itself, if the head passes freely, in like manner will the shoulders; the os uteri rarely, if ever, is capable of contracting upon the neck of the child, and thus preventing the advance of the shoulders; and should this prove the case, what can we do but wait with patience? After the delivery of the head, if the woman falls into deliquia, or if, after several pains, the shoulders do not follow, and the child's life be in danger from delay, we should naturally be induced to help it forward in the gentlest manner we are able, by passing a finger on each side as far as the axilla, and thus gradually pulling along.

III. Lastly, From the secundines, difficulty and danger sometimes arise.

1st, The rigidity of the membranes, and the contrary. From the first of these causes, the birth is sometimes rendered tedious; but as the same effect is much oftener produced by the opposite cause, and the consequences of the latter are more troublesome and dangerous than the former, we should always be exceedingly cautious of having recourse to the common expedient of breaking the membranes, which ought never to be done till we be certain the difficulty depends upon this cause; and, even then, the head of the child should be well advanced, and the membranes protruded almost as far as the os externum. Many inconveniences arise from a premature evacuation of the waters; for thus the parts become dry and rigid, a constriction of the os uteri for a time ensues, the pains often either remit or become less strong and forcing, though not less painful and fatiguing; the dilatation goes on so slow, and the labour becomes so severe, that the woman's strength and spirits, by the unprofitable labour, are quite overcome and exhausted; so that the head remains confined in the passage, merely from want of force of pain to push it forwards. The woman in the beginning of labour should therefore be treated with the utmost delicacy and gentleness. The work of nature is too often spoiled by officious hands. She should be seldom touched while the membranes are whole, lest they should be ruptured; and, even when touching is necessary, this should only be done when

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the pains begin to remit, and the tense membranous bag to relax.

2dly, Too great a quantity of water may prevent the uterus from contracting, and thus weaken the force of the pains. Though this may, however, occasion a delay, it will never be attended with more dangerous consequences; and the same advice already given will hold equally good in this case, that the membranes should never be broken till the soft parts be completely dilated; and we are assured that the difficulty or delay proceeds only from this cause.

3dly, The funis umbilicalis too long. The funis may be faulty from its too great length, or the contrary: thus the extraordinary length, by forming circumvolutions round the child's neck or body, sometimes proves the cause of protracting the labour. But as this can only happen when the chord is of an uncommon length, there is generally enough left to admit of the exit of the child with safety; and it is time enough, in general, after the child is born, to slip the noose over the shoulders or head: there is seldom occasion to divide the chord in the birth; a practice that may be attended with trouble and hazard.

The practice of introducing a finger in ano, to press back the coccyx, or to prevent the head, when it advances, from being retracted by circumvolutions of the chord, is now entirely laid aside; an expedient that can answer no end, but that of fretting and bruising the parts of the mother, and injuring those of the child.

Funis too short. The funis is sometimes thick and knotty, or preternaturally thickened by disease. In this case, part of the placenta may be separated as the child advances through the pelvis, and thus a flooding will ensue; or the funis may be actually ruptured, and occasion the death of the child, if the birth does not quickly follow. Such cases, however, rarely happen.

An inconvenience, at least fully as bad as the former, may arise from the too great length of the funis, though it may depend on other circumstances: viz.

4thly, The prolapsus of the funis before the head. In this case, the funis, if possible, should be pushed up above the presenting part; for, if the labour pains are slow, and the chord becomes cold, or the pulsation in it begins to grow languid, the circulation will thus be interrupted, and the life of the child destroyed. If the head is far advanced in the pelvis, and the child's life in danger, the delivery may be performed with the forceps. But to push up the head, and turn the child with a view to preserve its life, as many authors recommend, is a practice by no means advisable: we should seldom, in this position, be enabled to save the child; and turning under such circumstances can never be done but at the immediate hazard of losing the mother.

5thly, Placenta attached towards the cervix or os uteri. This case is truly melancholy; for, if the delivery is not speedily accomplished, the effusion from the uterine vessels will be so copious and profuse, that the unfortunate woman must in a very short time perish. On this occasion the delivery must be conducted in the best manner the judgment and skill of the

operator can direct, and with as much expedition as the safety of the mother will admit.

Thus, in most laborious cases, provided the woman's strength be supported, the management properly regulated, the natural moisture of the parts when deficient supplied, manual assistance very seldom becomes requisite: but as cases do occur, wherein nature, with all advantages, will fail, and the common methods of relief prove unsuccessful, recourse must be had to more powerful means, while the woman is able to support the conflict. In all such cases, the condition of the patient, the structure and state of the parts, and position of the presenting part of the child, must very carefully be considered.

Method of Delivery by Instruments.

WHEN the powers of nature are insufficient to expel the child, extraordinary assistance must be had recourse to. In laborious births, this is chiefly of two kinds.

- I. The head is either extracted as it presents: or,
- II. Its diameter is diminished previous to the extraction.

The head may be detained from advancing through the pelvis by all the causes formerly enumerated.—These are chiefly included in four general ones.

1. Weakness in the mother.
2. Narrowness of the pelvis.
3. The bulk of the head of the child; or,
4. Its disadvantageous position.

Whatever is the cause, when the natural pains begin to remit, and the parts of the woman begin to swell; when her strength declines, her pulse grows feeble, and there is no prospect of advantage to be gained by delay; measures must be taken for assisting the delivery, otherwise both mother and child may perish from neglect.

As instruments are never to be employed but in the most urgent and necessitous cases, and expressly with a view to preserve the life of mother or child, or both; those of a safe and harmless kind should always be made trial of, in preference to those of a destructive nature.

Use of the Forceps.

THE forceps is an instrument intended to lay hold of the head of the child in laborious births, and to extract it as it presents. This instrument, as now improved, in the hands of a prudent and cautious operator, may be employed without doing the least injury either to mother or child.

In every obstetrical case, wherein manual assistance becomes necessary, the contents of rectum and bladder should, if possible, be previously emptied.

The membranes also should be broken, the soft parts completely dilated, and the head of the child as far as possible advanced, previous to the use of any instrument.

The form and structure of the parts of the woman, the situation and progress of the presenting part of the child, must at this time be carefully considered. The concavity of the sacrum, for instance, will determine the progress of the labour. The touch of the vertex, fontanella, lambdoidal, or sagittal suture, the fore or back

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back part of the ear, or some part of the face, will ascertain the true presentation of the child.

The lower the head is advanced in the pelvis, our success with the forceps is the more to be depended on. For when it has proceeded as far as the inferior aperture, by means of this instrument it may be readily relieved: but when the head of the child is confined at the brim, both the application of instruments, and the extraction by this means, are exceedingly difficult and dangerous.

The head may be so firmly wedged in the pelvis, that the forceps can neither be introduced nor fixed without bruising or tearing the parts of the woman: whatever, therefore, insurmountable difficulties occur, either in applying or extracting with the forceps, the life of the mother must not be endangered by fruitless efforts: the head of the child must immediately be opened, and the delivery accomplished without further delay.

In laborious births, the proper forcep-cases may be reduced to two, which include, however, a considerable variety. These are,

I. The smooth part of the cranium.

II. The face, presenting.

The head may present,

1st, Naturally, when low advanced in the pelvis, with the vertex to the pubes, and the forehead or face in the hollow of the sacrum. Or,

2dly, When higher in the pelvis, the vertex may present with the face laterally, the ears to the pubes and sacrum. Or,

3dly, The fontanel may present with the face to the pubes and vertex to the sacrum; or with the vertex to the pubes and face to the sacrum.

1. When the head presents naturally. The woman in this case must be placed on her back across the bed, properly supported; the accoucheur, seated before or in a kneeling posture, after gradually lubricating the perinæum and vagina, must proceed gently to stretch the parts, by passing the hand in a conical manner through the os externum vaginae, pushing it forwards by the side of the child's head, till it advances as far as an ear, if possible: along this hand he is to guide a blade of the forceps, which with the other hand he introduces in the direction of the line of the pelvis, holding the handle backwards towards the perinæum, and keeping the clam closely applied to the child's head. This must be insinuated very gradually by a kind of wriggling motion, pushing it on till the blade is applied along the side of the head over the ear; he must then gently withdraw the first hand from the pelvis, with which he must secure the handle of the blade of the forceps already introduced, till the other blade be passed along the other hand, in the same slow cautious manner: the handles must then be brought opposite to each other, carefully locked, and, lest they slip in extracting, properly secured by tying a fillet or garter round them; but this must be loosed during the remission of pulling, to prevent the brain from being injured by the pressure. The extraction must be made by very slow and gentle degrees, and with one hand only, while the other is employed to guard the perinæum: the motion in pulling should be from blade to blade; the accoucheur must rest from time to time, and, if the pains are not gone, should

always in his efforts only co-operate with those of nature. The child and mother will suffer less by going on in this gradual manner than by precipitating the birth, which can never be done but at the risk of destroying both. If, in making the extraction, the forceps slip, they must be cautiously withdrawn blade by blade, and again introduced in the same manner.—When the tumor of the perinæum forms, and the vertex begins to protrude at the os externum, the accoucheur must rise from his seat, raise the handle gently upwards, and, by a half-round turn, bring the hind-head from under the symphysis or arch of the pubes; remembering carefully to guard the perinæum from laceration and its consequences, to which it is now so greatly exposed.

In attempting the introduction of either blade, if it meets with any interruption, it must be as often withdrawn, and pushed up again in a proper direction, till every difficulty be surmounted; and if, from the smallness or constriction of the parts, the introduction of the second blade shall seem impracticable, the former one must be withdrawn, and the latter must be first introduced.

2. The vertex may present with the face laterally in the pelvis. It is always difficult to apply the forceps till the bulky part of the head has passed the brim; and here it is not only difficult to the operator, but extremely hazardous to the patient, to introduce this instrument till the ear of the child has got under the pubes. When the ears thus present to pubes and sacrum, the woman should be placed on her side or knees; the most difficult blade of the forceps should be first applied, which is the one under the pubes; when both are passed, and properly secured, the patient should again be turned to her back, before the operator attempts to extract, and the head in this case (as the quarter-turn can seldom be made with safety) should be delivered in the manner wherein it presents; because, when confined any time in the passage, its figure is altered by the overlapping of the bones, in such a manner that it passes along, in general, with far less difficulty than to attempt to push up and make the mechanical turns; a work often altogether impracticable, by which contusion or laceration of the parts of the woman, and the most fatal consequences, may be occasioned. The handles of the forceps must here particularly be well pressed backwards towards the perinæum, that the clams may humour the curvature and intrusion of the sacrum, and accommodate themselves to the form of the child's head.

This is a case wherein the forceps often fail; if so, they will sometimes succeed by varying the mode of application, and fixing them over the forehead and occiput; if this method fails also, the size of the head must be diminished, and the extraction made with the blunt hook or crotchet.

3. The fontanella may present with the face to the pubes. This is the most common of the fontanel cases; though sometimes the face is lateral in the pelvis, sometimes diagonal, and sometimes it is turned to the sacrum. The true position is ascertained by the direction of the fontanel, and that of the ear. Here, as in other laborious births, nature should be intrusted as long as we dare. The head does not always de-

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scend mechanically through the capacity of the pelvis, as some practitioners have supposed; nor will the deviation from its ordinary mode of descent always of itself influence the delivery, at least very rarely in such a manner as to require extraordinary assistance. In whatever manner the head presents, when it is situated high in the pelvis, the delivery cannot be effected without difficulty or hazard; in such circumstances, the application of the forceps will frequently baffle the utmost efforts of the accoucheur, and the consequences of such attempts may prove fatal to mother and child.

When extreme weakness in the mother, floodings, convulsions, or other urgent symptoms, render it necessary to force the delivery, whether the face be to pubes or sacrum, the forceps may be applied along the ears, in the same manner as directed in a natural labour; and the head, for the reasons already given, should be brought along in the manner it presents: the extraction should be made with great deliberation, that the parts of the woman may have time to stretch; the perinæum must be carefully supported; the forceps must be gently released, when the head is delivered; and the rest of the delivery conducted as in a natural labour.

In this case, when situated high in the pelvis, the fontanel presenting, and the face either to pubes or sacrum, the long axis of the head intersects the short diameter of the pelvis, and very often, though the forceps be applied, and a firm hold of the head be obtained, it is not possible to bring it along with all the force we dare exert. If this method therefore fails, the common forceps should be cautiously withdrawn, and the long ones applied, if possible, over the forehead and occiput, when the size of the head, by the compression it suffers in passing along, being perhaps somewhat diminished, the extraction will be successfully performed. This method also failing, previous to the operation of embryotomy, Dr Leak's forceps, with the third blade, may be had recourse to. But of this little can be said with confidence, till the instrument has been more generally employed. From the difficulty of succeeding in the application of the common forceps, it may, *a priori*, be concluded, that the introduction of a third blade, even in the hands of an expert practitioner, however ingenious the invention, is an expedient not easily to be put in practice. Neither is Roonhuyse's lever, or a blade of the forceps passed up between the pubes and forehead or hind-head of the child, in order to procure the delivery of the head, to be recommended in such cases: however some have boasted of its success, it is an instrument that may do much mischief; and few practitioners can use it with safety.

II. *Face presenting.*—Of laborious births, face-cases, as we have already observed, are the most difficult and the most dangerous. From its length, roughness, and inequality, the face must occasion greater pain; and from the solidity of the bones, it must yield to the propelling force with much more difficulty, than the smooth moveable body of the cranium. Face-cases are the most troublesome that occur in the practice of midwifery, and in which the most expert practitioners may be foiled in their attempts; and these attempts, if too early exerted, will be followed in many instances

with fatal consequences. Whatever way the face presents, it should be allowed to advance as low as possible in the pelvis; by which means the access will be more easy, and the position, for the application of instruments, more favourable. In this awkward situation, much mischief may be done by rashness; whereas, if time be allowed, and the patient be properly supported, the delivery will generally end well.

The face may present with,

1. The chin to the pubes.
2. to the sacrum.
3. laterally.

From the difficulty of applying instruments in these cases, some authors recommend, as an universal practice, to turn the child, and deliver by the feet. But this in general is a dangerous practice, and seldom or never adviseable, except when the membranes remain entire, till the os uteri is completely dilated, and the head continues loose about the brim of the pelvis; and even then the propriety of the practice is doubtful; because if the head is small, or the pelvis be well proportioned, the face will descend without much difficulty; and if otherwise, besides the risk in attempting to turn, the child may be lost from the pressure of the chord, or the difficulty of extracting the head after the delivery of the body.

When assistance becomes necessary, the best practice in face-cases is the following: Having placed the patient in a convenient posture, let the accoucheur in the gentlest manner pass his hand within the pelvis; and, during the remission of pain only, endeavour to raise the head of the child, so that he may push up the shoulders entirely above the brim of the pelvis, and thus change the position of the face: by this means, if successful, he will be able to reduce the first of these cases, so as to make the fontanel present with the face to the pubes; he will reduce the second so as to bring down the vertex, with the face to the sacrum; and the third he will reduce to a vertex case, with the face lateral. The delivery may be afterwards trusted to nature; which failing, there is easier access for the application of instruments to make the extraction, as already directed. The success, however, of the accoucheur, in altering the position of the head, by pushing it up, will entirely depend on the time he is called; for, should the head be firmly wedged in the pelvis, no force he dares employ will be sufficient to alter the posture.

If therefore every attempt to reduce the face, and make the vertex or fontanel present, shall prove unsuccessful, and symptoms are urgent, the forceps must be applied over the ears of the child, and the extraction performed in the best manner the operator is able. And, failing these, immediate recourse must be had to the crotchet.

1. In the first case, previous to the introduction of the forceps, the chin, if possible, should be advanced below the pubes.
2. In the second, the chin should be advanced to the inferior part of the sacrum. And,
3. In the third, the chin should be as low as the hinder part of the tuber ischii: and although in general the head is to be extracted as it presents, if the operator meets with considerable resistance, it must be gently pushed up and turned with the chin, either laterally,

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terally, below the pubes, or into the hollow of the sacrum, according to the particular circumstances of the case, and in a direction best accommodated to the form and diameter of the pelvis.

Use of the Scissors, Crotchet, and Blunt Hook.

WHEN the head of the child, from its size, unfavourable position, or from a fault in the pelvis, cannot be protruded by the force of natural pains, nor extracted by the forceps, recourse must be had to more violent means, and the life of the child must be destroyed in order to preserve that of the mother. This operation was by the ancients called *embryotomy*.

When the head, from its extraordinary bulk, is detained at the brim of the pelvis; on evacuating the contents, the bones of the cranium immediately collapse, and the head is afterwards propelled by the force of the labour-pains; failing which only, the extraction must be made with the blunt hook or crotchet.

The unfavourable position of the head is of itself a cause insufficient to justify the use of destructive instruments, which ought never to be employed but in extreme cases, after every milder method has failed. From the difficult access to the cranium in order to make a perforation and evacuate the brain, a face-case makes a very troublesome and dangerous crotchet one. Very luckily, in narrow pelvises, the face rarely presents, and very seldom advances far in that direction; at other times, the position may be so altered, that the crown, the back of the ear, or some other part of the cranium, can be reached; otherwise the crotchet must be fixed in the mouth, orbit of the eye, &c. and the head brought along in that direction, till the scissors can be employed to open the skull.

But the grand cause of difficult labour is, the narrowness or distortion of the pelvis. For when, at the brim, instead of four inches and a quarter from pubes to sacrum, it measures no more than one and a half, one and three-fourths, two, or two inches and one-fourth, the use of instruments becomes absolutely requisite, and very frequently in those of two inches and one-half, and three inches; or when the diameters through the capacity, or at the inferior aperture, are retrenched in the same proportion, difficulties will in like manner arise, and the delivery, except the labour be premature, or the child of a small size, cannot be accomplished without the assistance of destructive instruments.

We judge of the form of the woman; by the progress of the labour; by the touch. When the fault is at the inferior aperture, the touch is pretty decisive; e.g. if a bump is felt in the os sacrum instead of a concavity; if the coccyx is angulated; if the symphysis pubis projects inwards in form of an acute angle; if the tuberosities of the ischia approach too near each other; or the one tuber be higher than the other; such appearances are infallible marks of a distorted pelvis. But when the narrowness is confined to the brim, this is only to be discovered by the introduction of the hand within the pelvis: the projection of the lumbar vertebrae over the sacrum, is a species of narrow pelvis that most frequently occurs in practice. In this case, the child's head, by the pressure it sustains between the pubes and sacrum, is moulded into a conical or sugar-

loaf form, the parietal bones are squeezed together, over-lapping one another, and will be felt to the touch when the labour is advanced, like an acute ridge, something in the form of a sow's back.

Instead of the complicated instrumental apparatus invented by the ancients, such as screws, hooks, &c. for fixing in, laying hold of, and extracting the head, as it presented, an operation in many cases difficult and dangerous, when the head was bulky or the pelvis narrow, as the woman frequently lost her life in the attempt; the practice of diminishing the size of the head, by opening the cranium and evacuating the brain, previous to the extraction, is a modern improvement, and an important one: the instruments for this purpose consist simply of a pair of long scissors, a sharp curved crotchet, and a blunt hook: these are preferable to every other, whether of ancient or modern construction.

When the accoucheur is under the disagreeable necessity of destroying the child to preserve the mother, she must be laid in the same position as already advised for the application of the forceps; and the same rules, recommended for the one operation, will in general apply to the other.

Thus, in the narrowest pelvis that occurs, previous to opening the cranium, the soft parts should be completely dilated, and the head of the child should be fixed steadily in the pelvis and advanced as far as possible; for while the head is high and loose above the brim, the application of instruments is very difficult as well as hazardous.

The long scissors must be cautiously introduced into the vagina, directed by the hand of the accoucheur; the points must be carefully guarded, till they press against the cranium of the child, which they must be made to perforate with a boring kind of motion, till they are pushed on as far as the rests; they must then be opened fully, carefully re-shut, half turned, and again widely opened, so as to make a crucial hole in the skull. They must afterwards be pushed beyond the rests, opened diagonally again and again, in such a manner as to tear and break to pieces the bones of the cranium; they must then be shut with great care; and withdrawn along the hand, in the same cautious manner as they were introduced, lest they should bruise or tear the uterus, vagina, or any other part of the woman. After a free opening in the cranium has thus been made, the brain must be scooped out with the fingers or blunt-hook, and the loose sharp pieces of bone must be carefully separated and removed, that no part of the woman be tore while the head is extracting. The teguments of the scalp should now be brought over the ragged bones of the cranium, and the woman should be allowed to rest an hour or two, according to her strength and other circumstances: the bones of the cranium will now collapse; and if the woman has as much strength remaining, or the pelvis be not much distorted, the head being thus diminished, will be protruded by the force of natural pains; otherwise it must be extracted, either by means of two fingers introduced within the cavity of the cranium, by the blunt-hook introduced in the same manner, guarding the point on the opposite side while making the extraction; or, failing these, by the crotchet, which, though dan-

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dangerous in the hands of an ignorant rash operator, may be employed by the prudent practitioner with as much safety as the bluntest instrument.

The method of introduction is the same with a blade of the forceps. The chief thing to be attended to is, to guard the point till it be applied against the head, and firmly fixed in its hold, which should always be somewhere on the outside of the cranium: provided a firm hold is obtained, no matter where, behind the ears, about the os petrosum, orbits of the eyes, maxilla inferior, &c. according to the presentation of the head. The woman being properly secured, and the handle of the instrument covered with a cloth, the operator must then pull, at first gently, afterwards more forcibly, resting from time to time, and endeavouring to make the extraction in the best manner the circumstances of the case will admit of. If the pelvis be much distorted, so that, by means of the utmost strength the accoucheur can exert, little purchase is made, he may apply to the opposite side a blade of the forceps, which are now so constructed as to lock with the crotchet; let him then bring the handles together, secure properly, and thus endeavour to make the extraction. Should this expedient also fail, the blade of the forceps must be withdrawn, the other blade of the crotchet must be applied, the handles brought together and secured, and the extraction made, moving from blade to blade.

Should the head present in such a manner, that, in attempting to extract it, the crotchet divides the vertebræ of the neck, and the head is thus severed from the body, an accident that can only happen in the hands of an ignorant blundering practitioner; the head must be pushed up above the brim of the pelvis, the crotchet or blunt hook must be fixed under the axilla, the arms must be brought down, and the body extracted, by fixing the crotchet below the scapula on the sternum, or among the ribs; the head must afterwards be extracted in the manner already advised: or should the head in extracting be pulled from the body, as may happen when the child has been long dead, or when it is putrid, the delivery of the body must be effected by means of the crotchet as now directed; a method preferable to that of turning, as some advise.

If the head, instead of yielding to the force of pulling, be at last cut and broken in pieces, the operator must endeavour to bring down an arm of the child, to fix the crotchet about the jaw or neck, pull at both holds, and thus attempt to make the extraction; this also failing, he must bring down the other arm, fix the crotchet in the thorax, and, in a word, must tear the child in pieces, that the delivery may be accomplished by any means.

In face-cases, where it is impracticable to alter the position, and when the pelvis is much distorted, the double crotchet is sometimes requisite; the handles must be well secured, kept well backwards towards the perinæum, and the motion always from blade to blade. It very seldom, however, happens, that there is occasion for the double crotchet: by this means the head is flattened in pulling; whereas if one blade only can be employed, the head is lengthened, and, in pulling,

can better accommodate itself to the shape of the pelvis as it passes along.

CHAP. III. *Preternatural Labour.*

In whatever manner the child presents when the body is delivered before the head, the birth is accounted preternatural.

Preternatural labours may be referred to one of the four following classes.

I. When one or both feet, knees, or the breech, present.

II. When the child lies across in a rounded or oval form, with the arm, shoulder, side, back, or belly, presenting.

III. When one or both of the upper extremities present, the child lying in the form of a sheath, the feet towards the fundus uteri, the waters evacuated, and the uterus strongly contracted round the body of the child.

IV. Lastly, Premature or flooding cases, or others in which it may be necessary to force the delivery, either previous to the rupture of the membranes, or quickly after it.

The causes of cross labours most commonly assigned by authors are, The obliquity of the uterus; circumvolutions of the funis umbilicalis round the child's body; the shortness of the funis, or attachment of the placenta towards the fundus uteri; shocks affecting the mother when pregnant, &c. The position of the fœtus may also be influenced by its own motion and stirrings, by the particular form and bulk of its body, by the manner of stretching of the uterus, by the quantity of liquor amnii, and by many other circumstances.

The symptoms that indicate an unfavourable position of the child, before it can be discovered by the touch, are very uncertain and fallacious: a cross birth may, however, be suspected,

1st, If the pains be more slack and trifling than ordinary.

2^{dly}, If the membranes be protruded in a long form like a gut, or the finger of a glove.

3^{dly}, If no part of the child can be discovered when the uterine orifice is considerably opened.

4^{thly}, If the presenting part through the membranes be smaller, feels lighter, and gives less resistance than the bulky ponderous head.

5^{thly}, Lastly, after the rupture of the membranes, if the meconium of the child be passed along with the waters, it is a sign that the breech presents, or that the child is dead.

Preternatural labours are difficult or hazardous, according to,

1. The form of the pelvis, and general health and constitution of the woman.

2. The bulk of the child, and its manner of presenting.

3. The time the waters have been evacuated, and the uterus contracted round the body of the child.

4. When complicated with plurality of children; the prolapsus of the funis umbilicalis; the limbs of the child entangled with the chord; profuse and violent flood-

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floodings from the attachment of the placenta towards the cervix uteri, &c.

Turning is often laborious, and always dangerous in proportion to the force used in searching for and bringing down the feet; though, in general, the difficulty and hazard are not so great, as in many cases strictly called *laborious*, when the head presents; the treatment of preternatural labours being better known, and for the most part easier put in practice.

Each class of the general division of cross labours includes a variety of different cases. By considering a few of every class, a general idea of the whole will be formed.

C L A S S I.

CASE I. The simplest and easiest case is the Agrippan posture, when the child presents with the feet.

The foot is to be distinguished from the hand, first, by the weight and resistance it gives to the touch; secondly, by the shortness of the toes; thirdly, by the projecting heel.

When the feet present in the passage, the labour should be allowed to go on as if natural. If the child be of an ordinary size, the woman in health, the parts well proportioned, in the way of assistance nothing further seems necessary but the application of a warm cloth round the body of the child, which must be properly supported till it advances as far as the pains are able to force it. If the size be ordinary, or rather small, it will sometimes make the mechanical turns, and be entirely pushed along by the force of the natural pains; but it generally stops at the shoulders, after the breech protrudes without the os externum, where the resistance is so great, that the accoucheur's assistance becomes requisite.

In this case, the patient must be placed on her back, properly supported; the hand of the accoucheur must be cautiously introduced; the parts of the woman must be gently stretched; the feet of the child must be laid hold of, and brought as low in the vagina as possible; a soft warm cloth must be wrapped round them, and the extraction must be performed in a slow cautious manner, making large motions in a circular or lateral direction, resting from time to time, if the pains are gone; and if not, always waiting for the natural efforts. When advanced as far as the breech, the body, if not already in a proper direction, must be pushed up, and gently turned with the face towards the mother's back; and to make sure that the face turns with the body, or to prevent the chin, vortex, or shoulders, from catching on the pubes, or angle of the sacrum, an extraordinary quarter-turn more must be made: this must be reversed previous to the extraction; and the difficulty arising from the obstruction of the shoulders must be removed in the following manner: While the breast and legs of the child are supported over the palm and fore-arm of the one hand of the accoucheur, which he draws towards one side, he must introduce two fingers of the other hand at the opposite side into the vagina, over the back-part of the shoulder, as far as the elbow, and endeavour in the most gentle manner to bring down the arm, always remembering in his movements to humour the natural motions of the joint: he must then shift hands, when the other arm is to be relieved in the same manner: both arms being brought

down, the woman must now rest a little, when a pain or two generally follows, and the head is also forced along. But should the woman be much exhausted, and if the head does not quickly advance, the child may be lost from delay. The extraction of the head in preternatural labours is often the most difficult and the most dangerous part of the delivery; the cause of resistance, when it does not advance, is chiefly owing to its confinement between the angle of the sacrum and pubes, when the bulky part of the head is detained at the brim; whether the resistance be here or towards the inferior aperture of the pelvis, if the head does not advance in a pain or two, the extraction must be made in this manner: While the right hand of the accoucheur supports the body of the child below, with two fingers pressing on either shoulder, the left hand and fingers must in the same manner be placed over the back of the neck, and pulling gently in the direction from pubes to sacrum, he must thus endeavour to bring it along: but, should the pelvis be narrow, or the child's head of a large size, or the face be laterally or anteriorly placed in the pelvis, or, what rarely happens, the os uteri contracted round the neck of the child; in either of these cases, the accoucheur will sometimes meet with the utmost difficulty. When the above method therefore fails, he must introduce two fingers of the right-hand into the child's mouth, while those of the left-hand are expanded over the shoulders, as already directed; and in this way he must endeavour to relieve it, pulling from pubes to sacrum, alternately raising and depressing the head till it advances low down, so that the face descends from the hollow of the sacrum, when the accoucheur must rise from his seat, and bring the hind-head from the pubes with a half-round turn, imitating that of a natural labour.

If the position be unfavourable, the face, if possible, should be turned to the sacrum, by pushing up the head, or by pushing back the chin: If the contraction of the uterus is the cause of resistance, which rarely occurs, it must be gently stretched with the fingers. Or if the difficulty arises from circumvolution of the chord round the legs, thighs, body, or neck of the child, these must be disengaged in the easiest manner possible; it is rarely necessary to divide the funis on this account.

Should every method fail in bringing down the head, the delivery must be effected by means of the forceps cautiously passed over the ears, with the handles under the child's body, in a direction downwards towards the perinæum. If the pelvis be very narrow, or the head of a large size, it must be opened by pushing the scissars through the occipital bone, so that the contents of the cranium may be evacuated, and the extraction made by means of the forceps, blunt-hook, or crotchet. But if the head, by the efforts to extract it, be actually severed from the body, and left behind in the uterus, an accident which sometimes occurs, it must be delivered by inclosing it in the forceps, while secured from rolling by pressing externally on the abdomen. If the forceps cannot be applied, the cranium must be opened, the texture of the brain destroyed, and the extraction performed by the fingers of the accoucheur, by the blunt-hook, or by the crotchet. If the under-jaw remains, the
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head may be effectually secured till locked in the forceps, or till its bulk be diminished, by introducing a finger into the mouth, thrusting it through the jaw under the chin, drawing it down, and passing a ligature through the perforation.

In cases where the child has been long dead, should the belly or thorax be distended with air or water, and prove the cause of obstruction, the contents must be evacuated by opening with the scissars, or tearing with the crotchet; and in general, where difficulties occur, the delivery must be accomplished in that manner the circumstances of the case will best admit of.

Case 2. When instead of two, one foot only falls into the vagina, the other is sometimes detained by catching on the pubes, and, if easily come at, should be brought down, always remembering to humour the natural motion of the joint; but, should the leg be folded up along the child's body, the attempt is sometimes both difficult and dangerous, and ought not to be persisted in, as the breech will either be forced down by the assistance of natural pains, or by gently pulling by one leg only.

Case 3. When one or both knees present, the delivery must be conducted in the same manner with that of the feet.

Case 4. When the feet offer along with the breech, this last must be pushed up, while the former are secured and brought down, till it be reduced to a footling case, and otherwise managed as above.

Case 5. The breech may present with the fore-parts to the mother,

- 1st, Anteriorly;
- 2^{dly}, Laterally; or,
- 3^{dly}, Posteriorly.

Sometimes the breech may be discovered, previous to the rupture of the membranes; but afterwards with more certainty, by the meconium of the child passed with the waters, and by the touch.

In whatever manner the breech presents, the delivery should be submitted to nature, till the child be advanced as far as the thorax, when the feet are to be brought down and laid hold of, the child, if necessary, pushed up, the mechanical turns effected; and the delivery otherwise conducted as in a footling case. There is much less hazard in general, agreeable to an old observation of Mauriceau, in allowing the child to advance double, than in precipitating the extraction by pushing up to bring down the feet before the parts have been sufficiently dilated; a practice difficult and troublesome to the operator; painful, and sometimes dangerous, to the mother; and by which the child is exposed to the risk of strangulation, from the retention of the head after the delivery of the body. If the child be small, though doubled, it will easily pass in that direction; if large, though the labour be painful, the natural throes are less violent and less dangerous than the preposterous help of the accoucheur: If the child thus advances naturally, it will be less exposed to suffer; if it does not advance, the parts of the mother will be prepared for the accoucheur to pass his hand into the pelvis, to raise up the breech, to bring down one or both feet, and deliver as above.

Weakness in the mother, floodings and convulsions,
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a very large child, or narrow pelvis, the prolapsus of the funis, or its compression between the thighs of the child, or between the child and pelvis, by which its life is endangered, if the chord cannot be reduced above the presenting part, are the only exceptions to the general rule of treating the breech as a natural labour.

The practice of helping forward the breech, by passing the blunt-hook under the ham, is now entirely laid aside: this can never be done with safety, till the breech be so low advanced, that the hand of the accoucheur can be used, which may be employed with more advantage as well as safety.

C L A S S II.

IN the former class of preternatural labours, it is adviseable to trust to nature in many cases, as the birth will often be accomplished without manual assistance: but when the child lies a-cross, no force of pain can make it advance in that position; and, without proper assistance, both the mother and child would perish.

If the accoucheur has the management of the labour from the beginning, the child may be turned, in the worst position, without difficulty; but when the waters have been for some time evacuated, and the uterus strongly contracted, turning is laborious to the operator, painful and dangerous to the mother. In such cases, the ancients endeavoured to make the head present; but, from its bulk, they often failed, and the attempt was often attended with fatal consequences. The method of delivering by the feet is the most important modern improvement in the practice of midwifery; an improvement to which many thousands owe their lives.

When the child lies in a transverse position, the accoucheur must insinuate his hand through the vagina into the uterus in the gentlest manner, search for the feet, bring them down with the utmost caution, and finish the delivery as in footling-cases. To effect this, the following rules should be observed.

1. The patient must be placed in a convenient posture, that the operator may be able to employ either hand, as the various circumstances of the case may require.

2. Though the best posture, in general, is laying the woman on her back, it will be sometimes necessary to turn her to her side; and, in these cases, where the abdomen is pendulous, where it is difficult to reach the feet, or where they lie towards the fundus uteri, the woman should be placed on her knees and elbows.

3. An exact knowledge of the true position of the child, and of the structure and state of the parts, should be acquired, before attempting to make the delivery.

4. The orifice of the uterus should be enlarged, so as freely to admit the hand; and the stronger pains should be abated, before any attempt be made to deliver.

5. Should the waters be drained off, the parts dry and rigid, and the uterus contracted round the child, warm oil must be injected into the uterus, otherwise its rupture may be endangered.

6. In passing the hand into the uterus, this must be done

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done in the gentlest manner; the parts must be well lubricated with butter or pomatum; the line of the pelvis must be attended to; the efforts of the operator must be slow and gradual; and thus the utmost rigidity in the soft parts will, in time, be overcome.

7. The hand must be introduced only during the remission of pain; when pain comes, the accoucheur must always rest; otherwise he may push his hand, or the foetus, through the body of the uterus.

8. In pushing up, to come at the feet, this must never be done with the points of the fingers, nor with the hand clenched, but with the palm of the hand, or the broad expanded fingers, and always during the remission of pain, and the latter should also be observed in bringing down the legs; but, in making the extraction of the body, the efforts of the operator should always co-operate with those of nature.

9. The hand should, if possible, be introduced along the anterior parts of the child; and both feet, if easily come at, should be laid hold of.

10. In turning, the accoucheur should never consider the child as dead, nor allow himself to be deceived by symptoms doubtful and fallacious; the child is sometimes born alive when he would least of all expect it; therefore, in pushing up, bring down the legs, or extracting the body, it should be handled with the greatest delicacy.

11. When the hand is within the pelvis, it should not always be moved in the line of the umbilicus, but rather towards one side of the spine, by which more room is gained, and the prominent angle of the sacrum avoided.

12. The hand should be passed as far as the middle of the child's body, before attempting to search for the feet; or before attempting to break the membranes, should these remain entire, till the aperture of the uterus will admit of the hand.

13. If the hand cannot pass the presenting part of the child to come at the feet, instead of violently pushing back, the part should be as it were lifted up in the pelvis, and moved towards a side; by which means difficulties may be surmounted, and great danger often prevented.

By attending carefully to the above rules, laceration of the uterus, floodings, convulsions, inflammations, and their consequences, may be prevented; accidents that frequently happen in the hands of ignorant rash operators.

Case 1.—The arm presenting. The right is to be distinguished from the left by laying hold of the child's hand, in the same manner as in shaking hands; and thus the general position of the child may be judged of.

When the accoucheur is called in early, the reduction is generally practicable; but if the arm protrudes through the vagina, and the shoulder be locked in the pelvis, it is needless, by fruitless efforts, for the accoucheur to fatigue himself, and distress his patient, to attain a point by which he will gain no very material advantage; as the hand can be passed into the uterus by the side of the child's arm, which will, of course, return into the uterus when the feet are brought down into the vagina.

In order to make the delivery, the hand of the ac-

coucheur, well lubricated, must be conducted into the uterus by the side of the child's arm, along the thorax, at the opposite side of the pelvis where the head lies; if any difficulty occurs in coming at the feet, this hand must be withdrawn, and the other introduced in its stead; and if still the hand cannot easily pass beyond the child's head or shoulder, the presenting part must be raised up, or gently pushed to a side, that one or both feet may be laid hold of, which must be brought as low as possible, pushing up the head and shoulders, and pulling down the feet alternately, till they advance into the vagina, or so low that a noose or fillet can be applied; and thus by pulling with the one hand by means of the noose, and pushing with the other, the feet can be brought down and the delivery finished, however difficult.

The method of forming the noose is by passing the two ends of a tape or garter through the middle when doubled; or, should the garter be thick, by making an eye on one extremity, and passing the other end through it: this, mounted on the points of the fingers and thumb of the accoucheur's hand, must be conveyed into the uterus, passed over one or both feet and ankles, and secured by pulling at the other extremity.

Case 2.—The side. This is discovered by feeling the ribs.

Case 3.—The back. This is discovered by feeling the spine.

Case 4.—The belly. This is known by the funis.

These cases occur rarely, as the uterus must with difficulty admit of such positions. When any of these parts do present, the child seldom passes any part of the brim of the pelvis, and is, in general, more easily turned than in several postures in which it may offer. The belly, from the difficulty with which the legs can be bended backwards, except the child be flaccid, putrid, or before the time, will very seldom directly present; if so, it will be early and readily discovered by the prolapsus of the funis, and there will be no great difficulty to come at the feet, and deliver. The rule in all these cases is, to pass the hand into the womb in the gentlest manner possible, and to search for the feet and bring them down.

C L A S S III.

WHEN the child lies longitudinally in the uterus, with the arm or shoulder presenting, and the head more or less over the pubes, or laterally in the pelvis, the feet towards the fundus uteri, the waters evacuated, and uterus contracted round the child's body; these are the most difficult and laborious of all the cases of preternatural labours. Here the protruding arm ought, if possible, to be reduced, and the head brought into the pelvis; for unless the child be very small, it is impossible for the head and arm to pass along together.

In order to effect the reduction of the arm, different instruments have been invented; but the hand of the accoucheur is preferable to every thing of this kind, whether of ancient or modern invention. This, conducted by the arm that protrudes, must be insinuated through the vagina into the uterus, as far as the shoulder of the child, which if the accoucheur can raise up, he will generally succeed in reducing the arm.

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arm. Should this method fail, he must attempt to push up the fore-arm at the elbow; but, in bending it, must be very cautious, to avoid overstraining or dislocating the joint. In whatever manner the reduction is accomplished, if any method proves successful, the arm must be retained till the head, by the force of natural pain, enters the pelvis, and prevents its return; otherwise the arm will descend as often as it is reduced.

But if the attempts for reduction prove impracticable, the woman must be placed on her knees and elbows, and the accoucheur, with great deliberation, must endeavour gently to slide up his hand between the uterus and child as far in the uterus as possible, to lift up the head and shoulders, and search for and bring down one or both feet, in the best manner the various circumstances of the case will admit of. As soon as they can be laid hold of, they must be gradually brought down into the vagina, so low that the noose can be applied over them, which must be fixed and pulled with the one hand, while the head and upper parts of the body are raised and gently pushed up with the other.

Should the arm have been long protruded without the os externum, much swelled, and cold; the waters drained off; the uterus strongly contracted; and the position of the child such as to render it impracticable, either to reduce the protruded limb or to search for and bring down the feet; the head, if easily come at, must be opened and extracted with the blunt hook or crotchet; or a crotchet must be fixed amongst the ribs, and the breech or feet thus pulled down.

Should the pelvis be very narrow, and unsurmountable difficulties occur, the arm must be twisted off at the elbow, though this expedient is rarely necessary; and the delivery must in general be accomplished as the prudence and judgment of the operator can best direct; always remembering, when one life must fall a sacrifice, that the tree must be preserved at the expense of the fruit.

In this, as in other cases, the swelling and coldness of the arm, and even want of pulsation in the artery, are not infallible signs of the child's death; and should this even be so, it makes little difference in the mode of delivery, unless that it will lead us to pay all our attention to the mother: For a living child gives no more assistance in the birth than a dead one, whatever authors have said to the contrary.

When both arms present, the delivery must be conducted in the same manner as when one only presents. The former case is less difficult than the latter, as the head seldom advances far when both arms fall into the passage, so that they can either be reduced, or there is easy access to come at the feet to bring them down and deliver.

CLASS IV.

WHEN the membranes remain entire, till the soft parts are so much dilated that the hand will readily find admittance; or when the hand can be passed within the cavity of the uterus, immediately after the rupture of the membranes, so that part of the water may be retained; the delivery may be accomplished, in the most troublesome preternatural cases, with the greatest safety and expedition. But when the waters have

been long evacuated, and the uterus closely contracted round the body of the child, the case will prove laborious to the operator, painful and dangerous to the mother and child.

When there is reason to suspect that the child lies across, which can often be ascertained, either by feeling the presenting part through the membranes, or by some of the signs of preternatural labours already mentioned; the woman should be managed in such a manner, that the membranes may be preserved entire as long as possible; for this purpose she should keep quiet in bed, and her posture should be such as is least favourable for straining, or exerting force during the pain: she should be touched as seldom as possible, till the os internum be sufficiently dilated. The accoucheur should then introduce his hand in a conical form, well lubricated, into the vagina, and through the aperture of the internal orifice, insinuating it between the uterus and the membranes, till it advances almost as high as the fundus uteri, when he must break the membranes, by pinching some part of them between a finger and thumb, or by forcibly pushing a finger through them; he must then search for, and endeavour to lay hold of, one or both feet, and deliver.

Should the membranes be ruptured in the attempt, he must be ready to run up his hand as quickly as can be done with safety, when, part of the waters by his arm being retained, the operation of turning will be facilitated. Should the placenta adhere on that side of the uterus where the hand is passed, it must again be withdrawn, and the other hand be introduced in the opposite side.

Floodings. It has been already observed, that a flooding seldom proves fatal to the mother before the seventh month of pregnancy; after which period, from its duration or excess, the life of both the mother and child may suffer. Should therefore a flooding attack a woman in the two last months of pregnancy, from whatever cause it may arise, and whether attended with labour-pains or not, if the hæmorrhagy be so considerable that she is ready to sink under it, and that cold applications and other means of checking the evacuation shall fail, the woman must be placed in a proper posture, her friends prudently apprised of her danger, and the delivery must be immediately performed, by stretching the vagina and os uteri, till the hand of the operator can easily gain admittance to break the membranes, catch hold of the feet, and extract the child.

If it can possibly be prevented, the membranes in flooding cases should never be broken till the aperture of the uterine orifice will freely admit the hand to pass, that, after the evacuation of the waters, the accoucheur may have it in his power either to make the delivery or not according as the effusion continues or abates.

Soon after attempting to stretch the parts, should the labour-pains come on, the waters begin to be collected, and the uterine hæmorrhagy diminish, the accoucheur must then withdraw his hand, and manage the delivery according to circumstances. And if, for instance, the child presents naturally, the delivery must be trusted to nature; otherwise, if the flooding continues, or the child presents across, the accoucheur must persist in his work, going on slowly, and with the utmost

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most delicacy, till he be able to reach the feet, to bring them down, and deliver; always remembering, during this process, that the strength of the woman, by proper nourishment, be supported.

But should the placenta adhere to the cervix, or upon the os uteri, the greatest danger is to be dreaded; for thus the flooding will commence from the moment the os uteri begins to stretch, and will increase so rapidly, that the woman, if not speedily delivered, must inevitably sink under it. The whole body of the placenta, in such cases, is sometimes separated when the labour has made but little progress; so that the woman will often perish whether delivery be attempted or not. As this, however, is the only expedient by which her life, and that of the child, can be saved; in every case where the placenta presents, which the accoucheur will readily discover by the touch of the soft pappy substance of that body, he must immediately place the woman in a proper posture, insinuate his hand gently by the side of the protruding placenta, break the membranes, search for the feet of the child, and bring them down, so that the delivery may be finished with all possible expedition; for, in this unhappy case, a few minutes delay may prove fatal.

The after-birth ought never to be extracted before the child, if it can possibly be avoided.

After delivery, time should be given for the uterus to contract, that nature may thus throw off the placenta, which never ought to be hurried away, unless the continuance or a recurrence of the hemorrhagy render it necessary.

Prolapsus of the funis. Difficulties arising from the funis falling down into the vagina, and presenting along with some part of the child, may, in this class of the division of preternatural labours, be included.

A pressure on the chord, in such a degree as to interrupt the circulation, must infallibly destroy the life of the child: hence a coldness and want of pulsation in the chord is the truest criterion of the death of the child; and hence, in every case where the chord is prolapsed before any bulky part of the child, if the delivery be not accomplished with expedition, the child will perish. This is only to be prevented by replacing the chord, and retaining it above the presenting part, till this last, by the force of labour-pains, be so far advanced as to prevent the return of the former; or the child must be turned and brought by the feet, provided this can be done with safety to the mother. But it is often difficult to succeed in the attempt of the one or other; and, if the woman has strong pains, such attempts are not to be hazarded, as the consequences may prove fatal.

When the accoucheur is thus situated between two puzzling difficulties, the preference must always be given to the mother. If the child be small, and the pelvis well formed, which may be known by the history of former deliveries, and if the labour goes on quickly, the child will generally be born alive; but if, on the contrary, the child be above the ordinary size, and the pelvis rather narrow, turning will prove a dangerous operation to the mother, and there is little prospect of saving the infant by this means.

Besides our former division of labours, *plurality of*

children, monsters, extra-uterine fetuses, and the Casarean operation, are parts of the subject that yet remain to be considered.

CHAP. IV. *Plurality of Children.*

THE case of twins often occurs: of triplets seldom: of quadruplets rarely: nor is there perhaps a single instance, where five or more distinct fetuses have been found contained in the human uterus, though many such fabulous histories have been recorded by credulous authors.

The signs of two or more children, such as the sudden or extraordinary increase of the uterine tumor, motion felt in different parts of the abdomen, &c. are very doubtful and fallacious: this can only be ascertained after the delivery of one child; and even then a recurrence or continuance of labour-pains is not a certain and infallible criterion; neither is the absence of pains a sure indication of the contrary; as many cases have occurred, where several days have intervened between the birth of a first and second child. The chief symptoms to be depended on are, 1st, The child being of a small size, and the quantity of liquor amnii so inconsiderable as not to account for the bulk of the woman in time of pregnancy. 2dly, The bleeding of the funis umbilicalis next the mother. 3dly, The remora of the placenta. 4thly, The uterine tumor not sensibly diminished, which, very soon after delivery, in ordinary births, will be found gradually shifting lower and lower, and will feel at last as if a hard circumscribed tumor like a ball between the umbilicus and pubes. Hence the utility of the general practice of applying the hand externally on the abdomen, in every case after delivery; by which an accurate knowledge will be formed of the nature and manner of the uterine contraction. When, from any of these circumstances, there is reason to suspect another child, the most certain and infallible manner of discovering it is, the passing of a finger, or the introduction of the hand into the uterus, where another set of membranes will be perceived, and probably some part of the child presenting through them.

The position of twins or triplets is commonly that which is most commodious, and which will occupy the least room in utero: their situation is often diagonal; tho' they may present in every possible posture. Thus, therefore, the general rules recommended for the delivery of one child, are equally applicable in the case of twins, triplets, &c.

It has been the general practice with many, after the birth of one child, to pass the hand immediately into the uterus, to break the membranes, catch hold of the feet of the child, and thus deliver. But this is certainly bad practice, whatever authors have said to the contrary. If the woman is healthy, and the child presents favourably, that is, with the head, breech, or feet, natural pains ought to be waited for, when the child will be expelled by the force of these only; failing which, manual assistance, as in other cases, must be had recourse to.

It very rarely happens, when the first birth is preternatural, that the second membranes are ruptured in making the extraction. Should this prove the case, the

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limbs of the children may be confounded, so that a leg and an arm, or three legs, or arms of different children, may present; which, however, will make little difference in the mode of delivery; the accoucheur will endeavour to lay hold of the foot or feet most readily within his reach, and will be cautious, in bringing them down, to make sure they belong to the same body.

If the child presents cross; if floodings, convulsions, or other dangerous symptoms, shall take place; if the woman has suffered much in the first labour; and if, after several hours, a recurrence of labour-pains does not ensue; the hand must then be introduced into the uterus, the membranes must be broken, and the child must be extracted by the feet; or, if the head remains locked in the pelvis, and, from want of strength in the woman, cannot be expelled, the treatment is the same as in other laborious births.

In twin-cases it may be recommended as a general rule, to avoid precipitating the delivery of the second child till the woman shall have rested a proper time, and till, by the contraction of the fundus uteri, the second set of membranes occupy the place of the first, and be protruded as far as the os externum; when, and not before, the delivery may safely be assisted, should circumstances occur to render such assistance necessary: whereas, by breaking the membranes and evacuating the waters when the child lies high in the uterus, a flooding may be brought on, or a spasmodic constriction of the uterus round the body of the child may be occasioned, which may render the delivery both difficult and dangerous.

The placenta of twins, triplets, &c. generally adhere, though sometimes they are distinct, and may be thrown off at different times after the birth of the different children; so that the practitioner should be on his guard, and never should leave his patient till he makes sure there be no more children. When a second child is discovered, no attempts ought to be made to extract the placenta till after the birth of the remaining child or children; as the woman would be subject to flooding, which might prove of fatal consequence before the uterus could be emptied of its contents.

In case of plurality of children, a second ligature should be applied on the funis, on that end next the mother, immediately after the birth of every child; and a gentle compression should be made on the abdomen of the woman after the first delivery, which must be gradually tightened after every succeeding one, to prevent the consequences of a sudden removal of uterine pressure, which is to be dreaded where the distension has been considerable.

The placenta, in such cases, must be managed in much the same manner as usual. In twins, &c. it generally separates with great facility, provided time has been given for the uterus to contract. Both chords should be gently pulled; and when it advances towards the uterine orifice, where, being large and bulky, it commonly meets with considerable resistance, it requires the introduction of a finger or two into the vagina for bringing down the edge, after which the body readily follows.

CHAP. V. Monsters.

THESE are of various sizes and forms, and, unless

very small, the posture favourable, and the woman well made, will prove the cause of a difficult and troublesome delivery. Sometimes a child is monstrous from a preternatural conformation of parts, such as a monstrous head, thorax, abdomen, &c. At other times, there is a double set of parts, as two heads, two bodies with one head, four arms, legs, &c. But such appearances very seldom occur in practice; and, when they do, the delivery must be regulated entirely according to the circumstances of the case. A large head, thorax, or belly, must be opened. If two bodies united together are too bulky to pass entire, they must be separated; the same of supernumerary limbs. If the posture be unfavourable, it must be reduced when practicable; otherwise the extraction must be made with the crotchet, in the best manner the circumstances of the case will admit of; always, in cases of danger or difficulty, giving the preference to the safety of the mother, without regarding that of the child.

CHAP. VI. Cesarean Operation.

WHEN the delivery could not be accomplished by other means, or when a woman died suddenly with a living child in her belly, an operation to preserve the life of mother and child in the former case, and to save the child in the latter, has been recommended, and successfully performed, by different authors, and in different ages.

This operation is of ancient date; it is the *scelia Casarea* or *partus Casareas* of the Latins, and the *hysterotomia* of the Greeks. Whether it was ever successfully performed on the living subject amongst the ancients seems uncertain; but that it has been successfully practised by the moderns on various occasions, and in several different countries of Europe, there are so many authentic histories on record, that the fact will scarce admit of doubt: but as this, like many other salutary institutions, has been much abused, and in many cases improperly and injudiciously employed, (for some of those women who survived the operation, were afterwards safely delivered of living children), the circumstances which render this operation necessary demand a very particular inquiry, viz.

1. A narrowness, or bad conformation of the bones of the pelvis.
2. Imperforated vagina, or contractions in the vagina, cicatrices, tumors, or callosities in the os uteri, &c.
3. The escape of the child through the uterus when torn.
4. Ventral conceptions.
5. Hernia of the uterus.
6. The position or bulk of the child.

It will be necessary carefully to examine these different causes, in order to show that they are by no means, in every case, sufficiently powerful motives for having recourse to it.

I. Bad conformation of the bones of the pelvis. When the hand of the operator cannot be introduced within the pelvis; or, in other words, when its largest diameter does not exceed one inch, or one inch and a half, this conformation is perhaps the only one which renders the Cesarean operation absolutely necessary: happily, however, such a structure very seldom occurs in practice; and when it does, the accoucheur will readily

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readily discover it, by attending to the following circumstances, and to the common marks of a narrow pelvis. Wherever the capacity of the pelvis is so strait as not to admit any part of the child's head to enter, nor two fingers of the accoucheur's hand to conduct proper instruments to tear, break down, and extract the child piece-meal; in this case, recourse must be had to the Cæsarean section; an expedient, though dreadful and hazardous, that will give the woman and child the only chance of life; and which, if timely and prudently conducted, notwithstanding of the many instances wherein it has failed, may be performed with some probability of success.

It is true, the success of the operation in the city of Edinburgh, where it has been done five times, has proved discouraging, as none of the women had the good fortune to survive it many days. This, however, is not the fault of the operation, but is to be imputed to the low, weak state of the patients at the time, who had previously been several days in labour, and their strength greatly exhausted, before the operator was called. Delivery by every other means was utterly impracticable; the operation, though the event was doubtful, alone gave a chance of life; and three of the children by this means were extracted alive.

Mr Hamilton surgeon and professor of midwifery in Edinburgh, having been an eye-witness of the operation the last time it was performed here, gives the following account of the case which fell under his observation.

Elisabeth Clerk, aged 30, had been married for several years, became pregnant, and miscarried in the third month; the expulsion of the abortion occasioned so severe a stress, as actually to lacerate the perinæum. Some time after her recovery, she was irregular, afterwards had one show of the menses, again conceived, and the child, as she imagined, arrived at full time. She was attacked on Monday the 3d of January 1774, about midnight, with labour-pains, which went on slowly, gradually increasing till Saturday the 15th, when she was brought from the country to the Royal Infirmary here. Upon examination, the pelvis seemed considerably distorted; but the body was otherwise well shaped, though of small size; the os externum vaginae was entirely shut up, nor could any vestige of vagina be observed, nor any appearance of labia pudendorum: instead of this, there was a small aperture at the superior part of the vulva, immediately under the mons veneris, probably about the middle anterior part of the symphysis pubis. This aperture (which had a small process on the superior part, somewhat resembling the clitoris) was no larger than just to allow the introduction of a finger; the meatus urinarius lay concealed within it; a consultation of surgeons was called, and the Cæsarean section was determined on. Having had no stool, nor voided any urine for two days, an injection was attempted to be thrown up; but it did not pass, nor was it possible to push the female catheter into the bladder. Mr William Chalmer was the operator in this case. At six in the evening, he made an incision on the left side of the abdomen in the ordinary way, through the integuments, till the peritonæum was exposed; two small arteries sprung, which were soon stopped by a slight compression: the wound was then continued through the peritonæum into the cavity of

the abdomen, when the bladder appeared slightly inflamed, much distended, reaching with its fundus near as far as the scrobiculus cordis: another unsuccessful attempt was made to pass the female catheter; at length a male catheter was procured, which was, after some difficulty, introduced into the bladder, and the urine evacuated to the quantity of above four pounds, high-smelled and fetid. This occasioned a necessary interruption for a few minutes, between making the opening into the abdomen and uterus; the bladder collapsing, the uterus, which before lay concealed, now came in view, through which an incision was made, and a stout male child was extracted alive; and immediately afterwards the secundines. The uterus contracted rapidly. After cleansing the wound, the lips were brought together by the quill-suture, and dressed superficially. The patient supported the operation with surprising courage and resolution; nor was there more than five or six ounces of blood lost on the occasion.

Being laid in bed, she complained of sickness, and had a slight fit of vomiting; but, by means of an anodyne, these symptoms soon abated: she was affected with universal coldness over her body, which also abated on the application of warm irons to the feet: she then became easy, and slept for four or five hours. Next morning, the 16th, about two o'clock, she complained of considerable pain in the opposite side, for which she was bled; and an injection was given, but without effect; for the pain increased, stretching from the right side to the scrobiculus cordis; nor did fomentations seem to relieve her; her pulse became frequent, she was hot, and complained of drought. At 7 A. M. the injection was repeated, but with no better success; and eight ounces more of blood were taken from the arm; a third injection still failed to evacuate any faeces; the drought increased; and the pulse rose to 128 strokes in a minute. At 11 A. M. the pulse became fuller; and the respiration much oppressed. No stool nor urine passed since the operation. At 12 she was bled again, when the sickness appeared less than formerly. She now took a solution of *sals Glauber. manna and cr. tart.* at short intervals; she vomited a little after the last dose, had a soft stool, and voided a small quantity of urine. At 3 P. M. her pulse was 136, and she had another stool, when thin faeces were evacuated; she was then ordered two spoonfuls of a cordial anodyne mixture every second hour: the vomiting now abated; the pulse became smaller and more frequent; she passed urine freely; but the pain and oppressed breathing increased. At seven P. M. her pulse rose to 142, and became weak and fluttering; she called for bread, and swallowed a little with some difficulty; her drought was intense; the dyspnoea still increased. She was now much oppressed, and began to toss; the pulse sunk and became imperceptible; she complained of faintness, but on belching wind her breathing was relieved, and the pulse returned, growing fuller and stronger; the pain of the side still increasing, 12 ounces of blood, very fizy, were taken away; and two glysters of warm water with oil were injected without effect: at 8 P. M. the pulse became less frequent and smaller; she complained much of the pain towards the scrobiculus cordis: her breathing was much oppressed; her belly was tense, and swelled as

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big as before the operation; her pulse was now small and feeble; she looked ghastly; and expired a little after eight, 26 hours after the operation.

It is to be regretted that the relations would not permit the body to be opened.

Since the first certain accounts of the operation successfully practised by a fow-gelder on his own wife, in the beginning of the 16th century, there are on record above 70 well-attested histories, wherein it has been successfully performed: for, of all the cases related by authors, it has not proved fatal to the patient above once in ten or nine instances; which evidently shows the propriety of the practice, and probability of success, both in regard to the mother's own recovery, and for certainly preserving the life of the child. But it should never be attempted, excepting in those cases only where it is absolutely impossible to deliver the woman by any other means whatever; for there are pelvises to be met with, where, without having recourse to this operation, both mother and child must inevitably perish: such have occurred to many practitioners, who, from want of resolution or from ill-founded prejudice, have allowed their patients to perish from neglect, contrary to a well-known maxim in physic, That, in a desperate case, it is better to employ a doubtful and even desperate remedy, than to abandon the patient to certain and utter ruin. Such, for instance, is a case related by Saviard, of a girl aged 27, whose stature was only three feet, who came to lie-in at Paris, in the *Hotel Dieu*; every method but the operation was in vain attempted; both mother and child died. Mauriceau also relates the history of a woman who was left to die, where the aperture of the pelvis was so small as not to admit the hand of the accoucheur. And, not to multiply instances, Mr De la Roche gives a case where the woman had been seven days in labour; the child was saved by the operation; but the woman died the fifth day after, probably from its being too long delayed: the distance, in this subject, from the lower vertebra lumborum and os pubis, was no more than two fingers breadth. The operation, when the necessity is evident, ought therefore to be early performed, that the patient, who from her make and constitution is generally delicate and puny, may have every chance of recovery in her favour, without being exhausted by the fruitless efforts of a tedious and painful labour, as too often has been the case. On these occasions, the prudent accoucheur should call in the advice of his elder brethren of the profession, and, by his cautious and prudent conduct, avoid every cause of censure or reproach.

Exostoses from the bones of the pelvis is a species of deformity very rarely met with in practice, and which seldom or never takes place to such a degree as to render this operation necessary.

II. Constriction, callosity, tumors, &c. about the vagina or os tincæ. The vagina and os tincæ are often affected with constrictions from cicatrices, with callosities and tumors; but it is seldom, if ever, necessary to perform the Cæsarean section on this account. Tumors in the vagina may generally be removed with safety, even after the commencement of labour, and delivery happily succeed; or it may be sometimes practicable for the accoucheur to pass his hand by the side of the tumor, to turn the child, and

deliver. With regard to constrictions in the vagina, and callosities in the os uteri, there are many instances where, at the commencement of labour, it was impossible to introduce a finger into the vagina; yet the parts have dilated as labour increased, and the delivery terminated happily. At other times, the dilatation has begun during pregnancy, and been completed before delivery. There is a history, for instance, in the *Mem. de l'Acad. des Scienc.* 1712, of a woman whose vagina was no larger than to admit a common writing quill; she had been married at 16, and conceived 11 years after: towards the fifth month of her pregnancy, the vagina began to dilate, and continued to do so till full time, when she was safely delivered. Guilemeau dilated, and La Mott extirpated, callosities in the vagina and os tincæ, when the children were successfully expelled by the force of natural labour.

Harvey relates a case where the whole vagina was grown together with cicatrices; nature, after a tedious labour, made the dilatation, and a large child was born.

La Mott mentions his having delivered three women, who had not the smallest vestige of an orifice through the vagina to the uterus. Dr Simpson cut through a callosity of an os uteri which was half an inch thick, &c.

Upon the whole, tumors in the vagina, or about the orificium uteri, may be safely extirpated without danger of hemorrhagy or other fatal symptoms, and the delivery will happily succeed: and if the vagina be impervious, the os externum shut up, or the labia grown together, the parts should be opened with the scalpel, rather than risk an operation, at best in the issue doubtful and precarious: an operation never allowable in such cases, and therefore universally improper in diseases or malconformation of the soft parts of generation. If the os externum be entirely closed, if the cavity of the vagina be entirely filled up, or the passage considerably obstructed by tumors, callosity, or constriction from cicatrice, and there is no reason to suspect a fault in the pelvis, of which a judgment may be formed by the common marks of deformity, under size, or a rickety habit; it is by much the best practice to open a passage through the vagina, and deliver the woman in the ordinary way. If there be no defect in the pelvis, the head of the child, or any other bulky part that presents, will advance in this direction, till it meets with a resistance in the soft parts: thus the teguments will at length be protruded before the child's head, in form of a tumor, when a simple incision downwards to the perinæum, in the direction of the anus, will remove the cause of difficulty, by relieving the head; the child will afterwards safely pass, and the wound will heal without any bad consequence.

The state of the pelvis, and progress of the labour in these cases, may often be learned by the touch of the finger in ano.

III. Lacerated uterus is another cause for which this operation has been recommended. The uterus may be ruptured from violence in making the delivery; or such an accident may happen naturally, either from the cross presentation of the child in time of pregnancy, or in time of labour, when the pelvis is narrow: these cases are generally fatal; and it is very seldom,

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When the child cannot be extracted by the natural passages, tremors, singultus, cold sweats, syncope, and the death of the mother, for the most part, so quickly follow, that it will at least seem doubtful, to a prudent humane practitioner, how far it would be adviseable, after so dreadful an accident, the woman apparently in the agonies of death, rashly to perform another dangerous operation, even with a view to preserve the child, till he had waited till the mother recruits or expires.

If part of the child be contained within the uterus, and the feet can be reached, the practice is to deliver by the orifice of the womb: but when the whole fœtus has escaped entirely without the uterus, the Cæsarean operation is recommended as the only means of preserving both mother and child.

If the operation on this occasion be ever allowable, it may be asked,

1. At what time must it be performed?
2. Would it not have the appearance of inhumanity to have recourse to this expedient immediately after the uterus bursts, when the woman is seemingly ready to expire, although it be the only time when there is a chance of saving the child?
3. In most cases where this accident happens, should the Cæsarean section be made, is it not highly improbable that the mother will survive so terrible a laceration?
4. For if it be done with a view to save the mother, in what manner is the extravasated blood, &c. to be evacuated from the cavity of the abdomen?

What seems to make cases of this kind unfavourable, when the accident happens in time of labour, is,

1^{mo}, That here the parts before rupture in most cases are in a gangrenous state.

2^{do}, As the rupture is commonly towards the cervix, there is generally a much greater hemorrhagy, by reason of the slow contraction of the uterus at this place.

3^{io}, The uncertainty, whether, or how long, the patient will survive it, seems also a considerable obstacle to the operation under such disagreeable circumstances, *Ne occidisse videatur, quem fors interemit.*

IV. Ventral conceptions is a fourth indication for this operation. These are either in the ovaria, tubes, or cavity of the abdomen, and seldom arrive at great size; or are retained, very often a long time, without occasioning much complaint. The issue of these conceptions has also been no less various than extraordinary; for after being retained for a great many years in an indolent state, at length abscesses or ulcerations have formed, and they have been discharged through all the different parts of the abdomen.

Most women feel pain and violent motion at the time of ordinary delivery in these cases of ventral conception; if therefore the operation be ever necessary,

now is the proper time to perform it. But in general, as the separation of extra-uterine fœtuses from their involucra may occasion immediate death in many cases, from the vast hemorrhagy that might ensue from the non-contraction power of the parts to which they adhere; unless they point outwardly, or excite the most violent symptoms, they ought universally to be left to nature.

V. Herniæ of the uterus are seldom or never sufficient to induce us to perform the Cæsarian section, as the uterus is very rarely influenced in such a manner, that the orifice cannot be reached, and the delivery successfully made. Many instances are to be found among surgical authors, where deliveries, under such circumstances, have been happily performed, without having recourse to so hazardous an expedient. Thus Mauriceau mentions a case, where the uterus, in a ventral hernia, was pushed along with the intestines above the belly, and contained in a tumor of a prodigious size; the woman, however, was delivered at the end of her time in the ordinary way. La Mott relates the history of a woman in a preternatural labour, whose uterus and child hung down pendulous to the middle of her thigh, but whom, notwithstanding, he safely delivered: and Ruysch gives a case where the midwife reduced the hernia before delivery; although it was prolapsed as far as the knee, the delivery was safely performed, and the woman had a good recovery.

Lastly, The position or bulk of the child.

Since the practice of turning the child and delivering by the feet, and the late improvement of obstetrical instruments, this operation is never to be performed on account of position, monstrosity, or any other obstacle on the part of the child.

Upon the whole, when the pelvis is faulty to such a degree, that no instrument can be conducted to tear and extract the child, this perhaps is the only case wherein this operation should be performed on the living subject. Incisions through the teguments of the abdomen to extract extra-uterine fœtuses, or bones of fœtuses, do not properly fall under the name of *Cæsarean section*, as that name implies incision of the uterus also.

When a woman advanced in pregnancy dies suddenly, either by accident or by natural disease, the Cæsarean section is recommended as an expedient to preserve the life of the child. This is a very proper measure, provided the death of the mother be ascertained; but sometimes it is a very nice and difficult point to distinguish between a deliquium and death; and therefore the accoucheur on such an occasion must act with the utmost circumspection. If the operation be delayed but a very short while after the mother expires, it will probably be in vain to make the attempt; for, whatever fabulous stories may be related to the contrary, there are few authentic cases of the fœtus of any animal surviving the mother, perhaps an hour; and therefore every thing should be in readiness to extract the child with all possible expedition, after the event of the mother's death. But, in such cases, the agonies of death often perform the part of labour, and the child is sometimes thrown off *in articulo mortis*; or the os uteri is so much dilated, that there is easy access to pass the hand, turn the child, and deliver. Thus one should be very cautious in having recourse to this opera-

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operation, even in the above circumstances; which should never be done,

1. Till the death of the mother be ascertained beyond doubt;
2. Till the state of the os uteri be examined;
3. Till the consent of the relations be obtained;

And,

Lastly, It need not be undertaken, except where the mother dies suddenly, between the 7th and 9th month.

It is unnecessary where the disease has been lingering; in such cases the child commonly dies before the mother.

When it is doubtful whether the child be alive or not, it may be determined by applying the hand on the abdomen of the mother about the time of, and for a little while after, her death, when the life of the child will be discovered by its motions and struggling.

Thus having pointed out the different causes that determine this operation, it may be observed, that it is a frightful and hazardous one; and although performed successfully in a number of cases, yet, in many others, it has failed, and the woman has died either immediately or soon after. It should never, therefore, be undertaken but on extraordinary and desperate occasions; and then it is not only adviseable, but incumbent, on every practitioner to whom such cases occur.

To conclude, it may not be improper to give a few directions with regard to the method of performing the operation on the living subject.

Having emptied the bladder, and evacuated the contents of the intestines with repeated emollient glysters; the patient being encouraged, with proper cordials, and every other requisite in readiness, she must be placed on a table or bed, with her left side gently raised with pillows or bolsters, and properly secured by assistants. An incision must be made with a common convex scalpel, beginning rather below the navel at the middle space between it and the spine of the os ilium, carrying it obliquely forwards towards this bone, so that the wound in length may exceed six inches. This external wound is to be carried through the common teguments of the abdomen till the peritonæum is exposed, when the operator should rest a little, till the hemorrhagy be entirely abated. He must then, with great caution, make a small opening through this membrane, introduce his finger, and upon this a scalpel (which is preferable to scissors), and with great expedition make a complete dilatation; he must now wipe away the blood with a sponge, press the omentum or intestines gently to a side, if in the way, and endeavour to discover to what part of the uterus the placenta adheres, that it may be avoided in making the incision. This may easily be known by a thickness and solidity in the part, which distinguish it from the rest of the uterus; it is still more easily discovered when the membranes are entire. The blood-vessels are less in number, and smallest in the middle and anterior part of the uterus, which therefore, if the placenta does not interfere, is the proper place for making the incision, which must be performed with the utmost attention, lest the child should be wounded: if the membranes are entire, more freedom

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may be used, and *vice versa*. The direction and length of the wound of the uterus must be the same with the external one. The child must now be quickly extracted, and the placenta carefully separated: these must be given to an assistant, who will divide the chord, and take care of the child, as the operator's attention must be wholly bestowed on the mother. The coagulated blood, &c. being removed by a sponge wrung out of warm water (lest the uterus or intestines be protruded, which are very troublesome to reduce), the lips of the external wound must be quickly brought together, and retained by an assistant till secured by a few stitches; generally three will be sufficient: as many needles should be ready threaded with pretty large broad ligatures; the middle stitch ought to be made first; the needle should be introduced at a proper distance, *i. e.* about an inch and one-fourth from the side of the wound, carrying it first from without inwards, and then from within outwards, securing with a double slip a knot, to be ready to untie, lest violent tension or inflammation should ensue; under the knot a soft compress of lint, sharpee, or rolled plaster, should be applied, and the whole dressings must be secured by a proper compress and bandage. The patient must be afterwards treated in the same manner as after lithotomy, or any other capital operation.

Quæritur, To what cause is the unsuccessful event of this operation to be imputed? When the operation proves fatal, to what immediate cause are we to ascribe the death of the patient? Is it nervous, or uterine irritation, from cutting, that kills? Is it internal hemorrhagy, or the extravasation of fluids into the cavity of the abdomen? Or are not the fatal consequences rather to be imputed to the access of the air on the irritable viscera? This can only therefore be prevented by exposing these parts for as short a space of time as possible. Dr Monro, the present anatomical professor at Edinburgh, in making experiments on young small animals, such as bitches, cats, frogs, &c. by opening the cavity of the abdomen, and tying the biliary ducts, remarks, that though a large opening into the abdomen be made by incision, if the wound be quickly closed and stitched, the animal will recover, and no bad consequences follow; but if exposed a few minutes to the air, dreadful pain soon comes on, which the creature expresses by the severest agonies; convulsions at last ensue, and death within four or six hours after the operation. On opening the abdomen after death, the whole viscera are found to be in an inflamed state, and universally adhering to one another. He has often repeated the experiment, and the same appearances as often take place.

May not the analogy here justly apply to the human subject? And, in performing the Cæsarean operation, should we not be very careful that the viscera be exposed as little as possible, and that the wound be covered with the utmost possible expedition?

CHAP. VII. *Of the Section of the Symphysis.*

M. Baudelocque, as has already been observed, condemns this operation; and, from what he has advanced, apparently with reason. As no theory, however, can be looked upon as thoroughly established until it

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be confirmed by experience, this gentleman has collected together a number of the principal *facts* relating to this subject. He supposes, that unless it has been successful in saving both the life of the woman and child, the cutting of the symphysis of the pubes cannot by any means be said to have answered its purpose. It is not sufficient that the child has shown some signs of life at its birth, and that the mother has survived for some time. In this respect the Cæsarean operation has the advantage of it, as it always saves the life of the child, and it is very rare for the woman to sink under it immediately. He is of opinion, that there is scarcely one of the cases of this operation, the relation of which may not be justly contested, or solid objections raised against it; either because the operators have been deceived with regard to the dimensions of the pelvis and of the child's head, or because they have greatly exaggerated the advantage gained by the separation of the bones.—The first and most remarkable instance of success in this operation is of a woman named *Souchot*; but though it is not denied that the woman was delivered, and recovered after the operation, yet it has been said by those who take the contrary side, that there was no necessity for performing it. It is certain that this woman had been delivered four times before; in all of which cases the child was killed. M. Baudelocque does not enter into the merits of this question: he considers only what advantage could possibly be gained by it.

“Whatever degree of separation (says he) took place between the ossa pubis after the section of the symphysis, it must have augmented the size of the passage; that is an incontestable fact: but how much did it enlarge in the direction in which it was originally too narrow? The solution of this problem would be easy, if we knew the dimensions of *Souchot's* pelvis as well as we know those of her child's head. According to the estimation made of it by the physicians who performed the operation, the diameter of the pelvis was only two inches and a half in the direction from the pubes to the sacrum superiorly, and that of the child's head was just three inches and a half. The excess of the latter was consequently one inch, as well as the amplitude to be procured to the former. A separation of two inches and a half between the ossa pubis, the greatest which it was then thought could be obtained, not being able to give more than six lines to the diameter of the pelvis in the aforesaid direction, they thought to make the remaining surplus of the head pass into the separation between the bones; and, moreover, they had the precaution to make the partial protuberances pass successively through the strait, in order to get another line by that means; so that by this system, the section of the pubes produced a result of 13 lines at least, considering it relatively to delivery. Notwithstanding this ingenious calculation, and this great product, the passage was still found narrow enough to give some obstruction to the child's head, and to endanger its life.

“It seems evident that this plan was not formed till after the execution; and that they have only sought to explain what they must have done according to the opinion which they entertained that the diameter of the child's head was an inch larger than that of the

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pelvis, and not according to what they did and observed: because no one had yet determined the product of a separation of two inches and a half between the ossa pubis, with respect to the different diameters of the pelvis, and particularly respecting that which goes from before backward; because they did not measure the separation as they affirm they did, neither in the case of *Souchot* nor in any other; because the accoucheurs of that woman were then agitated, *much agitated*, as they have publicly confessed; lastly, because this great product, and those sage calculations which we admire in their history of it, were not then necessary. Though they have allowed but two inches and a half to the small diameter of the superior strait, other accoucheurs equally skilful have assigned it six lines more; and they were not deceived if they considered it a little diagonally, as the smallest diameter of the child's head always presents; that is to say, from one of the sides of the projection formed by the base of the sacrum to the symphysis of the pubes.”

Our author now goes on to show at great length, that the pelvis of the woman in question was less out of proportion than had been represented; that only two lines of enlargement were necessary, and no more than two were obtained. In like manner, he says, that all the other women upon whom M. Sigault operated were equally well formed excepting one named *Vespres*. This woman died after passing five days in great agony. The ossa pubis were separated about an inch and an half; and in consequence of this separation, the sacro-iliac symphyses were plainly injured, as well as the neighbouring parts. On inspecting the body, these were found open, with the periosteum separated from them: there was also a collection of purulent matter of a dark grey colour, extending very far into the cellular tissue of the left iliac fossa, &c.

In this case, both the mother and her child perished; and M. Baudelocque looks upon it to be sufficient to show the inefficacy of the operation: and he tells us, that out of five women whom Sigault delivered in this way, one died, and four of the children; but M. Le Roy, a more successful operator, out of an equal number saved all the children. In a case related by this gentleman, the ossa pubis are said to have separated two inches; and by parting the thighs, an opening of near three inches was obtained: but in this case again, M. Baudelocque controverts the measurements of Le Roy. Another woman named *Du Belloy*, on whom the operation was performed, began to walk on the tenth day after; and this seems to be almost the only case against which M. Baudelocque has not some objection. He mentions, however, an experiment performed on the body of a woman who had died on the 11th day after the Cæsarean operation had been performed in the linea alba. The body was œdematous, which rendered the case more favourable; and a dead child was placed in the belly, after taking out the uterus. The pelvis was only 20 lines in the small diameter, and four inches and a quarter in the transverse. The diameter of the child's head was but three inches five or six lines from one parietal protuberance to the other; the trunk was thin, and every part of the body had been pressed and kneaded, to restore as much as possible the suppleness which death had taken away. An attempt was then made

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to bring the child through the pelvis by pulling its feet; but it was found impossible thus to disengage it farther than the breast. The symphysis of the pubes was then laid bare by an incision of two inches and an half; preserving, below, the anterior commissure of the *labia pudendi*; and above, an extent of 18 or 20 lines under the inferior angle of the Cæsarean operation. The ossa pubis separated at first no more than nine lines; which opening was augmented as gradually as possible to 21 lines by separating the thighs, and afterwards it was farther increased to two inches and an half by pulling the hips. It was next attempted to bring away the head, which had spontaneously placed itself in the most advantageous situation: but, though several gentlemen of the profession employed their strength successively at the trunk, and on the lower jaw with two fingers in the mouth, it did not advance a single line; nor would it pass the strait until M. Baudelocque seconded those efforts by pressing on the head with one hand placed in the belly, and by compressing it strongly in the direction of its thickness. At the instant when it cleared the strait, the inferior angle of the incision in the teguments tore to the vulva; and the wound was so lengthened towards that of the Cæsarean operation, that those three openings were very near making but one. The sacro-iliac symphyses, which were already a little open, and the ligaments and periosteum ruptured by the time that the ossa pubis were separated 21 lines, now gave way entirely, and with so much noise as to be distinctly heard by every one of the assistants. The ossa pubis, after the passage of the head, remained at the distance of three inches from each other; the angle of the right os pubis was two inches and six lines from the centre of the projection of the sacrum, and the angle of the left os pubis only two inches and three lines; so that the diameter of the pelvis was augmented seven lines in one way and ten in the other.

From this experiment, M. Baudelocque concludes, that very little advantage can be expected from the operation where the pelvis presents only 18 or 19 lines, or even 21 superiorly, such as was the pelvis of Belloy. We must observe, however, that we cannot argue with propriety from a dead to a living subject: though if the measurements are wrong, as our author *afterwards* says, although at first he "had nothing particular to object" to her case, the whole argument in favour of the operation must fall to the ground.

Objections of a similar kind are made to every other case which M. Baudelocque relates: And as it is impossible for those who were not acquainted with the parties to judge of the propriety or impropriety of the operation, we shall content ourselves with describing from M. Baudelocque the appearances met with in the body of a woman who had died in the operation. "The left *labium* was very much swelled and livid; the sacro-iliac symphyses were of a brownish colour to the extent of an inch at least, on account of the blood extravasated under the periosteum which was detached from them; they were overflowed with a purulent and ichorous discharge, more abundant on the left side than the right; and which sprung from the bottom of them, through several openings, which were so many rents, whenever the ossa ilia were mo-

ved and pressed towards the sacrum; the left symphysis was open five lines, and the right only three. A gangrenous abscess was seen on the right side behind and above the acetabulum, which extended to the anterior and inferior part of the uterus, where there was an eschar of the same nature; an ulcer also gangrenous, and in form of a chink, was observed in the posterior part of that viscus, from the upper part of its neck to the insertion of the ligament of the ovary, and it penetrated into its cavity. The diameter of the pelvis was two inches and a half from the pubes to the base of the sacrum; five inches from one side to the other; and four and an half from one acetabulum to the sacro-iliac junction of the opposite side. The section had been made on the left os pubis, which was cut clean, and without the smallest notch."

From these, and a number of other examples which our limits will not allow us to insert, our author deduces the following conclusions.

"Though the section of the pubes has been thought more simple, more easy, and certain, than the Cæsarean operation, at a time when experience had not yet demonstrated the difficulties it might present, and the dangers that might follow it, ought we to think the same of it at present? How many times already has it been necessary to have recourse to the saw to separate the ossa pubis? and how often has it not been found impossible to procure any distance between them after the separation? How often has this operation produced a free passage for the child, whose preservation ought necessarily to enter into the plan of the operator, as well as that of the mother, and constitute a part of its success?"

"This new operation will appear more simple and less painful than the Cæsarean, if we only consider the extent of the incision, and the nature and importance of the parts concerned in it: that is an indisputable fact. It is only the teguments and the fat which is divided, at most only two inches and an half, and the symphysis of the pubes; there are usually only small vessels cut, incapable of furnishing much blood, and the instrument does not touch the uterus; the child comes into the world by the way that nature intended, and which the section of the pubes renders more or less accessible; there is no considerable hæmorrhagy to be feared, nor those extravasations of milky and purulent matter which almost always mortally injure the interior viscera which they fall upon; there are no absolute difficulties in the execution of this operation but what arise from the intimate consolidation of the bones; and it no way exposes women to subsequent hernias which have been so frequently seen after the Cæsarean operation: this is the idea which its partisans have had of it, and which the greater part of them still entertain.

"But the section of the pubes seldom procures the child an easy exit; for hitherto the greater part have died in the passage, or have been victims, a few minutes after their exit, to the efforts necessary to effect it. When the separation of the ossa pubis has been made, it has not always been possible to remove them from each other, on account of the consolidation of the ilia with the sacrum; and this case, which does not seem to be exceedingly rare, and which cannot be known till after the operation, renders it fruitless, and cannot dispense us from the Cæsarean operation.

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"If we reflect ever so little on the danger to which the child is exposed in a preternatural labour, where we are obliged to bring it by the feet, and on the small number that then escape death, when the mother's pelvis has not, pretty nearly, all its natural dimensions, we discover another source of accidents which accompanies the section of the pubes; and which we doubtless should diminish, if we could commit the expulsion of the child to the contractions of the uterus, or take hold of the head with the forceps, as some practitioners have already done: but, except in that very small number of cases, the child has always been extracted by the feet whether the head presented or not

"Though this operation very seldom secures the child's life, even when the pelvis is not excessively deformed, it is not then always exempt from the severest consequences to the mother. The death of both is certain when that deformity is extreme. The consequences of a spontaneous separation of the ossa pubis, and of the ossa ilia and sacrum, in some natural or laborious labours, long since announced those which might be expected from this new operation; the example of Vespres, those of the fifth woman on whom M. le Roy performed it, the fourth by M. Cambon, that at Arras, at Dusseldorp, at Spire, at Lyons, at Gênes, that by M. Riollay, by M. Matthiis, &c. have proved that it was not without cause that those accidents were dreaded. A devestation in the external parts and the neck of the uterus; an inflammation and gangrene of that viscus; collections of purulent, sanious, and putrid matter, in the cellular tissue of the pelvis; a hernia of the bladder between the ossa pubis; echimoses along the psoæ muscles; injury to the canal of the urethra; incontinence of urine, and gangrenes more or less profound, &c. form the group of accidents of which this new operation is susceptible. Granting that those of the Cæsarean operation are as formidable for the mother, at least it presents a certain resource, exempt from every danger, for the child. Which of the two operations, therefore, ought to be preferred?

"Even if we could, without inconveniences to the woman, obtain a separation of two inches and an half between the ossa pubis after the section of their symphysis, the Cæsarean operation would still be the sole resource in cases of extreme deformity of the pelvis; the section of the pubes cannot enter into comparison

with it, except when the small diameter of the superior strait shall have, at least, an extent of two inches and an half. Though I suspended my judgment, at the time I published my first edition, concerning the preference to be given to one of these two methods, in the latter case, till I could procure more positive information of the innocence or danger of so considerable a separation; though I required that men who had no interest in vaunting this new method to the detriment of the former; in one word, that its adversaries should have seen a separation of two inches and an half, without a rupture of the sacro-iliac symphyses, and without inconveniences to make me adopt this new operation; at present, better informed on all these points, I am not afraid to reject it, and to affirm that no one has ever separated the ossa pubis two inches and a half without destroying the life of the woman. It has had no success but when it has been performed on pelvises at least two inches three quarters in the small diameter, and when the separation has been limited to much less than the point to which they fancied it was carried; in those cases, in fact, where it was absolutely useless; the pelvis being larger still, for I have found it to be more than three inches in some of the women. The section of the pubes cannot at present maintain any comparison with the Cæsarean operation; at most, it might be substituted for the forceps, in some particular cases only: for it cannot, without great inconveniences, give the pelvis an increase of more than two lines from the pubes to the sacrum superiorly; and that instrument may, without danger, reduce the diameter of the child's head as much. But what practitioner would prefer a new operation, which seems to be surrounded by rocks on every side, to one that has been crowned with a thousand successes? If we allow the former any advantages, they would never be more evident than in that species of locked head mentioned by Roederer, where we cannot (says he) introduce any instrument between the head and the pelvis, at whatever part we attempt it; in that case, it would merit a preference over opening the cranium, the use of the crutchets, and the Cæsarean section proposed by the same author: it would be preferable also, in cases where the inferior strait is contracted transversely, provided that a small separation were sufficient to give that diameter the necessary extent."

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PART III. OF DISORDERS SUBSEQUENT TO DELIVERY.

CHAP. I. *Of the general Management of Women after Delivery.*

THE woman being delivered of the child and placenta, let a soft linen-cloth, warmed, be applied to the external parts; and if she complains much of a smarting soreness, some pomatum may be spread upon it. The linen that was laid below her, to sponge up the discharges, must be removed, and replaced with others that are clean, dry, and warm. Let her lie on her back, with her legs extended close to each other; or upon her side, if she thinks she can lie easier in that position, until she recovers from the fatigue: if she is

spent and exhausted, let her take a little warm wine or caudle, or, according to the common custom, some nutmeg and sugar grated together in a spoon: the principal design of administering this powder, which among the good women is seldom neglected, is to supply the want of some cordial draught, when the patient is too weak to be raised, or supposed to be in danger of retchings from her stomach's being overloaded. When she hath in some measure recovered her strength and spirits, let the cloths be removed from the parts, and others applied in their room; and, if there is a large discharge from the uterus, let the wet linen below her be also shifted, that she may not run the risk of catching cold.

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When the patient is either weak or faintish, she ought not to be taken out of bed, or even raised up to have her head and body shifted, until she is a little recruited; otherwise she will be in danger of repeated faintings, attended with convulsions, which sometimes end in death. To prevent these bad consequences, her skirt and petticoats ought to be loosened and pulled down over the legs, and replaced by another well warmed, with a broad head-band to be slipt in below, and brought up over her thighs and hips: a warm double cloth must be laid on the belly, which is to be surrounded by the head-band of the skirt pinned moderately tight over the cloth, in order to compress the viscera and the relaxed parietes of the abdomen, more or less as the woman can easily bear it; by which means the uterus is kept firm in the lower part of the abdomen, and prevented from rolling from side to side when the patient is turned: but the principal end of this compression is to hinder too great a quantity of blood from rushing into the relaxed vessels of the abdominal contents, especially when the uterus is emptied all of a sudden by a quick delivery. The pressure being thus suddenly removed, the head is all at once robbed of its proportion of blood, and the immediate revulsion precipitates the patient into dangerous lypothymia.

For this reason the belly ought to be firmly compressed by the hands of an assistant, until the bandage is applied; or, in lieu of it, a long towel, sheet, or roller, to make a suitable compression: but for this purpose different methods are used in different countries, or according to the different circumstances of the patients. The head-cloaths and shift ought also to be changed, because with sweating in time of labour they are rendered wet and disagreeable. Several other applications are necessary, when the external or internal parts are rent or inflamed; misfortunes that sometimes happen in laborious and preternatural cases. We shall conclude this chapter with giving some necessary directions with regard to air, diet, &c.

Although we cannot remove the patient immediately after delivery into another climate, we can qualify the air so as to keep it in a moderate and salutary temper, by rendering it warm or cold, moist or dry, according to the circumstances of the occasion. With regard to diet, women, in time of labour, and even till the ninth day after delivery, ought to eat little solid food, and none at all during the first five or seven: let them drink plentifully of warm diluting fluids, such as barley-water, gruel, chicken-water, and teas: caudles are also commonly used, composed of water-gruel boiled up with mace and cinnamon, to which, when strained, is added a third or fourth part of white wine, or less if the patient drinks plentifully, sweetened with sugar to their taste: this composition is termed *white caudle*; whereas, if ale is used instead of wine, it goes under the name of *brown caudle*. In some countries, eggs are added to both kinds; but, in that case, the woman is not permitted to eat meat or broths till after the fifth or seventh day: in this country, however, as eggs are no part of the ingredients, the patient is indulged with weak broth sooner, and sometimes allowed to eat a little boiled chicken. But all these different preparations are to be prescribed weaker or stronger, with regard to the spices, wine, or ale, according to the different constitutions and

situations of different patients: for example, if she is low and weak, in consequence of an extraordinary discharge of any kind, either before or after delivery, or if the weather is cold, the caudles and broths may be made the stronger; but if she is of a full habit of body, and has the least tendency to a fever, or if the season is excessively hot, these drinks ought to be of a very weak consistence, or the patient restricted to gruel, tea, barley and chicken-water, and these varied according to the emergency of the case.

Her food must be light and easy of digestion, such as panada, biscuit, and sago; about the fifth or seventh day she may eat a little boiled chicken, or the lightest kind of young meat; but these last may be given sooner or later according to the circumstances of the case and the appetite of the patient. In the regimen as to the eating and drinking, we should rather err on the abstemious side than indulge the woman with meat and strong fermented liquors, even if these last should be most agreeable to her palate; for we find by experience that they are apt to increase or bring on fevers, and that the most nourishing and salutary diet is that which we have above prescribed. Every thing that is difficult of digestion, or quickens the circulating fluids, must of necessity promote a fever, by which the necessary discharges are obstructed, and the patient's life endangered.

As to the article of sleeping and watching, the patient must be kept as free from noise as possible, by covering the floors and stairs with carpets and cloths, oiling the hinges of the doors, silencing the bells, tying up the knockers, and in noisy streets strowng the pavement with straw; if, notwithstanding these precautions, she is disturbed, her ears must be stuffed with cotton, and opiates administered to procure sleep; because watching makes her restless, prevents perspiration, and promotes a fever.

Motion and rest are another part of the nonnaturals to which we ought to pay particular regard. By tossing about, getting out of bed, or sitting up too long, the perspiration is discouraged and interrupted; and in this last attitude the uterus, not yet fully contracted, hangs down, stretching the ligaments, occasioning pain, cold shiverings, and a fever: for the prevention of these bad symptoms, the patient must be kept quiet in bed till after the fourth or fifth day, and then be gently lifted up in the bed-cloaths, in a lying posture, until the bed can be adjusted, into which she must be immediately reconveyed, there to continue, for the most part, till the ninth day; after which period women are not so subject to fevers as immediately after delivery. Some there are who, from the nature of their constitutions, or other accidents, recover more slowly; and such are to be treated with the same caution after as before the ninth day, as the case seems to indicate: others get up, walk about, and recover, in a much shorter time: but these may some time or other pay dearly for their foolhardiness, by encouraging dangerous fevers; so that we ought rather to err on the safe side than run any risk whatsoever.

What next comes under consideration is the circumstance of retention and excretion. We have formerly observed, that, in time of labour, before the head of the child is locked into the pelvis, if the woman has not had an easy passage in her belly that same day, the rectum and colon ought to be emptied by a glyster

Manage-
ment after
Delivery.

Floodings. glyster, which will assist the labour, prevent the disagreeable excretion of the fæces before the child's head, and enable the patient to remain two or three days after, without the necessity of going to stool. However, should this precaution be neglected, and the patient very costive after delivery, we must beware of throwing up stimulating glysters, or administering strong cathartics, lest they should bring on too many loose stools, which, if they cannot be stopt, sometimes produce fatal consequences, by obstructing the perspiration and lochia, and exhausting the woman, so as that she will die all of a sudden; a catastrophe which hath frequently happened from this practice. Wherefore, if it be necessary to empty the intestines, we ought to prescribe nothing but emollient glysters, or some very gentle opener, such as manna, or *elect. lenitivum*. But no excretion is of more consequence to the patient's recovery than a free perspiration; which is so absolutely necessary, that unless she has a moisture continually on the surface of her body for some days after the birth, she seldom recovers to advantage: her health, therefore, in a great measure, depends upon her enjoying undisturbed repose, and a constant breathing sweat, which prevents a fever, by carrying off the tension, and assists the equal discharge of the lochia: and when these are obstructed, and a fever ensues with pain and restlessness, nothing relieves the patient so effectually as rest and profuse sweating, procured by opiates and sudorifics at the beginning of the complaints; yet these last must be more cautiously prescribed in excessive hot than in cool weather.

The last of the nonnaturals to be considered are the passions of the mind, which also require particular attention. The patient's imagination must not be disturbed by the news of any extraordinary accident which may have happened to her family or friends: for such information hath been known to carry off the labour-pains entirely, after they were begun, and the woman has sunk under her dejection of spirits; and, even after delivery, these unseasonable communications have produced such anxiety as obstructed all the necessary excretions, and brought on a violent fever and convulsions, that ended in death.

CHAP. II. *Of violent Floodings.*

ALL women, when the placenta separates, and after it is delivered, lose more or less red blood, from the quantity of half a pound to that of one pound, or even two; but should it exceed this proportion, and continue to flow without diminution, the patient is in great danger of her life: this hazardous hemorrhagy is known by the violence of the discharge, wetting fresh cloths as fast as they can be applied; from the pulse becoming low and weak, and the countenance turning pale; then the extremities grow cold, she sinks into faintings, and, if the discharge is not speedily stopped or diminished, is seized with convulsions, which often terminate in death.

This dangerous efflux is occasioned by every thing that hinders the emptied uterus from contracting, such as great weakness and lassitude, in consequence of repeated floodings before delivery; the sudden evacuation of the uterus; sometimes, though seldom, it proceeds from part of the placenta's being left in the

womb; it may happen when there is another child, or more, still undelivered; when the womb is kept distended with a large quantity of coagulated blood: or when it is inverted by pulling too forcibly at the placenta.

In this case, as there is no time to be lost, and internal medicines cannot act so suddenly as to answer the purpose, we must have immediately recourse to external application. If the disorder be owing to weakness, by which the uterus is disabled from contracting itself, so that the mouths of the vessels are left open; or, though contracted a little, yet not enough to restrain the hemorrhagy of the thin blood; or if, in separating the placenta, the accoucheur has scratched or tore the inner surface or membrane of the womb; in these cases, such things must be used as will assist the contractile power of the uterus, and hinder the blood from flowing so fast into it and the neighbouring vessels; for this purpose, cloths dipped in any cold astringent fluid, such as oxycrate, or red tart wine, may be applied to the back and belly. Some prescribe venesection in the arm, to the amount of five or six ounces, with a view of making revulsion; if the pulse is strong, this may be proper; otherwise, it will do more harm than good. Others order ligatures, for compressing the returning veins at the hams, arms, and neck, to retain as much blood as possible in the extremities and head. Besides these applications, the vagina may be filled with tow or linen-rags, dipped in the abovementioned liquids, in which a little alum or sacchar-saturni hath been dissolved; nay, some practitioners inject proof-spirits warmed, or, soaking them up in a rag or sponge, introduce and squeeze them into the uterus, in order to constrict the vessels.

If the flooding proceeds from another child, the retention of the placenta, or coagulated blood, these ought immediately to be extracted; and if there is an inversion of the uterus, it must be speedily reduced. Should the hemorrhagy, by these methods, abate a little, but still continue to flow, though not in such a quantity as to bring on sudden death, some red wine and jelly ought to be prescribed for the patient, who should take it frequently, and a little at a time; but above all things chicken or mutton broths, administered in the same manner, for fear of overloading the weakened stomach, and occasioning retchings; these repeated in small quantities, will gradually fill the exhausted vessels, and keep up the circulation. If the pulse continues strong, it will be proper to order repeated draughts of barley-water, acidulated with elixir vitriol: but if the circulation be weak and languid, extract of the bark, dissolved in *aq. cinnamomi tenuis*, and given in small draughts, or exhibited in any other form, will be serviceable; at the same time, lulling the patient to rest with opiates. These, indeed, when the first violence of the flood is abated, if properly and cautiously used, are generally more effectual than any other medicine.

CHAP. III. *Of the After-pains.*

AFTER-PAINS commonly happen when the fibrous part of the blood is retained in the uterus or vagina, and formed into large clots, which are detained by the sudden contraction of the os internum and exter-

Lochia.

num, after the placenta is delivered: or, if these should be extracted, others will sometimes be formed, though not so large as the first, because the cavity of the womb is continually diminishing after the birth. The uterus, in contracting, presses down these coagula to the os internum; which being again gradually stretched, produces a degree of labour-pains, owing to the irritation of its nerves: in consequence of this uneasiness, the woman squeezes the womb as in real labour; the force being increased, the clots are pushed along, and when they are delivered she grows easy.—The larger the quantity is of the coagulated blood, the severer are the pains, and the longer they continue.

Women in the first child seldom have after-pains; because, after delivery, the womb is supposed to contract and push off the clots with greater force in the first than in the following labours: after-pains may also proceed from obstructions in the vessels, and irritations at the os internum. In order to prevent or remove these pains, as soon as the placenta is separated and delivered, the hand being introduced into the uterus, may clear it of all the coagula. When the womb is felt through the parietes of the abdomen larger than usual, it may be taken for granted that there is either another child, or a large quantity of this clotted blood; and, which soever it may be, there is a necessity for its being extracted. If the placenta comes away of itself, and the after-pains are violent, they may be alleviated and carried off by an opiate: for, by sleeping and sweating plentifully, the irritation is removed, the evacuations are increased, the os uteri is insensibly relaxed, and the coagula slide easily along. When the discharge of the lochia is small, the after-pains, if moderate, ought not to be restrained; because the squeezing which they occasion promotes the other evacuation, which is necessary for the recovery of the patient. After-pains may also proceed from an obstruction in some of the vessels, occasioning a small inflammation of the os internum and ligaments; and the squeezing thereby occasioned may not only help to propel the obstructing fluid, but also (if not too violent) contribute to the natural discharges.

CHAP. IV. *Of the Lochia.*

WE have already observed, that the delivery of the child and placenta is followed by an efflux of more or less blood, discharged from the uterus, which, by the immediate evacuation of the large vessels, is allowed to contract itself the more freely, without the danger of an inflammation, which would probably happen in the contraction, if the great vessels were not emptied at the same time: but as the fluids in the smaller vessels cannot be so soon evacuated, or returned into the vena cava, it is necessary that, after the great discharge is abated, a slow and gradual evacuation should continue, until the womb shall be contracted to near the same size to which it had before pregnancy; and to this it attains about the 18th or 20th day after delivery, though the period is different in different women.

When the large vessels are emptied immediately after delivery, the discharge frequently ceases for several

hours, until the fluids in the smaller vessels are propelled into the larger, and then begins to flow again, of a paler colour.

The red colour of the lochia commonly continues till the fifth day, though it is always turning more and more serous from the beginning: but, about the fifth day, it flows of a clear, or sometimes (though seldom) of a greenish tint; for, the mouths of the vessels growing gradually narrower by the contraction of the uterus, at last allow the serous part only to pass: as for the greenish hue, it is supposed to proceed from a dissolution of the cellular or cribriform membrane or mucus, that surrounded the surface of the placenta and chorion; part of which, being left in the uterus, becomes livid, decays, and, dissolving, mixes with and tinctures the discharge as it passes along.

Though the lochia, as we have already observed, commonly continue till the 18th or 20th day, they are every day diminishing in quantity, and soonest cease in those women who suckle their children, or have had an extraordinary discharge at first; but the colour, quantity, and duration, differ in different women: in some patients, the red colour disappears on the first or second day; and in others, though rarely, it continues more or less to the end of the month: the evacuation in some is very small, in others excessive: in one woman it ceases very soon, in another flows during the whole month: yet all of these patients shall do well.

Some allege, that this discharge from the uterus is the same with that from a wound of a large surface; but it is more reasonable to suppose, that the change of colour and diminution of quantity proceed from the slow contraction of the vessels; because, previous to pus, there must have been lacerations and imposthumes, and, in women who have suddenly died after delivery, no wound or excoriation hath appeared upon the inner surface of the womb, which is sometimes found altogether smooth, and at other times rough and unequal, on that part to which the placenta adhered. The space that is occupied before the delivery, from being six inches in diameter, or 18 inches in circumference, will, soon after the birth, be contracted to one third or fourth of these dimensions.

CHAP. V. *Of the Milk-fever.*

ABOUT the fourth day, the breasts generally begin to grow turgid and painful: We have formerly observed, that, during the time of uterine gestation, the breasts in most women gradually increase till the delivery, growing softer as they are enlarged by the vessels being more and more filled with fluids; and by this gradual distension they are prepared for secreting the milk from the blood after delivery. During the two or three first days after parturition, especially when the woman has undergone a large discharge, the breasts have been sometimes observed to subside and grow flaccid; and about the 3d or 4th day, when the lochia begin to decrease, the breasts swell again to their former size, and stretch more and more, until the milk, being secreted, is either sucked by the child, or frequently of itself runs out at the nipples.

Most

Milk-fever. Most of the complaints incident to women after delivery, proceed either from the obstruction of the lochia in the uterus, or of the milk in the breasts, occasioned by any thing that will produce a fever; such as catching cold, long and severe labour, eating food that is hard of digestion, and drinking fluids that quicken the circulation of the blood in the large vessels; by which means the smaller, with all the secretory and excretory ducts, are obstructed.

The discharge of the lochia being so different in women of different constitutions, and besides in some measure depending upon the method of management, and the way of life peculiar to the patient, we are not to judge of her situation from the colour, quantity, and duration of them, but from the other symptoms that attend the discharge; and if the woman seems hearty, and in a fair way of recovery, nothing ought to be done with a view to augment or diminish the evacuation. If the discharge be greater than she can bear, it will be attended with all the symptoms of inanition; but as the lochia seldom flow so violently as to destroy the patient of a sudden, she may be supported by a proper nourishing diet, assisted with cordial and restorative medicines. Let her, for example, use broths, jellies, and asses milk; if the pulse is languid and sunk, she may take repeated doses of the *confect. cardiac.* with mixtures composed of the cordial waters and volatile spirits: subastringents and opiates frequently administered, with the *cort. Peruvian.* in different forms, and austere wines, are of great service. On the other hand, when the discharge is too small, or hath ceased altogether, the symptoms are more dangerous, and require the contrary method of cure: for now the business is to remove a too great plenitude of the vessels in and about the uterus, occasioning tension, pain, and labour, in the circulating fluids; from whence proceed great heat in the part, restlessness, fever, a full, hard, quick pulse, pains in the head and back, nausea, and difficulty in breathing. These complaints, if not at first prevented, or removed by rest and plentiful sweating, must be treated with venesection and the antiphlogistic method.

When the obstruction is recent, let the patient lie quiet, and encourage a plentiful diaphoresis, by drinking frequently of warm, weak, diluting fluids, such as water-gruel, barley-water, tea, or weak chicken-broth.

Should these methods be used without success, and the patient, far from being relieved by rest, plentiful sweating, or a sufficient discharge of the obstructed lochia, labour under an hot dry skin, anxiety, and a quick, hard, and full pulse, the warm diaphoretics must be laid aside; because, if they fail of having the desired effect, they must necessarily increase the fever and obstruction, and recourse be had to bleeding at the arm or ankle to more or less quantity, according to the degree of fever and obstruction; and this evacuation must be repeated as there is occasion. When the obstruction is not total, it is supposed more proper to bleed at the ankle than at the arm; and at this last, when the discharge is altogether stopped, her ordinary drink ought to be impregnated with nitre.

If she is costive, emollient and gently opening glysters may be occasionally injected; and her breasts

must be fomented and sucked, either by the mouth or pipe-glasses. If by these means the fever is abated, and the necessary discharges return, the patient commonly recovers; but if the complaints continue, the antiphlogistic method must still be pursued. If, notwithstanding these efforts, the fever is not diminished or removed by a plentiful discharge of the lochia from the uterus, the milk from the breasts, or by a critical evacuation by sweat, urine, or stool, and the woman is every now and then attacked with cold shiverings; an abscess or abscesses will probably be formed in the uterus or neighbouring parts, or in the breasts; and sometimes the matter will be translated to other situations, and the seat of it foretold from the part's being affected with violent pains: these abscesses are more or less dangerous according to the place in which they happen, the largeness of the suppuration, and the good or bad constitution of the patient.

If, when the pains in the epigastric region is violent, and the fever increased to a very high degree, the patient should all of a sudden enjoy a cessation from pain, without any previous discharge or critical eruption, the physician may pronounce that a mortification is begun; especially if, at the same time, the pulse becomes low, quick, wavering, and intermitting: if the woman's countenance, from being florid, turns dusky and pale, while she herself, and all the attendants, conceive her much mended; in that case, she will grow delirious, and die in a very short time.

What we have said on this subject regards that fever which proceeds from the obstructed lochia, and in which the breasts may likewise be affected: but the milk-fever is that in which the breasts are originally concerned, and which may happen tho' the lochia continue to flow in sufficient quantity; nevertheless, they mutually promote each other, and both are to be treated in the manner already explained; namely, by opiates, diluents, and diaphoretics, in the beginning; and, the prescriptions failing, the obstructions must be resolved by the antiphlogistic method described above. The milk-fever alone, when the uterus is not concerned, is not so dangerous, and is much more easily relieved. Women of an healthy constitution, who suckle their own children, have good nipples, and whose milk comes freely, are seldom or never subject to this disorder, which is more incident to those who do not give suck, and neglect to prevent the secretion in time; or, when the milk is secreted, take no measures for emptying their breasts. This fever likewise happens to women who try too soon to suckle, and continue their efforts too long at one time; by which means the nipples, and consequently the breasts, are often inflamed, swelled, and obstructed.

In order to prevent a too great turgency in the vessels of the breasts, and the secretion of milk, in those women who do not choose to suckle, it will be proper to make external application of those things which, by their pressure and repulsive force, will hinder the blood from flowing in too great a quantity to this part, which is now more yielding than at any other time: for this purpose, let the breasts be covered with *emp. de minia*, *diapalma*, or *emp. simp.* spread upon linen, or cloths dipped in camphorated spirits, be frequently applied to these parts and the arm-pits; while the patient's diet and drink is of the lightest kind, and

given

Evacua-
tions.

given in small quantities. Notwithstanding these precautions, a turgency commonly begins about the third day; but by rest, moderate sweating, and the use of these applications, the tension and pain will subside about the fifth or sixth day, especially if the milk runs out at the nipples: but if the woman catches cold, or is of a full habit of body, and not very abstemious, the tension and pain increasing, will bring on a cold shivering succeeded by a fever; which may obstruct the other excretions, as well as those of the breast.

In this case, the sudorifics above recommended must be prescribed; and if a plentiful sweat ensue, the patient will be relieved; at the same time the milk must be extracted from her breasts, by sucking with the mouth or glass: should these methods fail, and the fever increase, she ought to be bled in the arm; and instead of the external applications hitherto used, emollient liniments and cataplasms must be substituted, in order to soften and relax. If, in spite of these endeavours, the fever proceeds for some days, the patient is frequently relieved by critical sweats, a large discharge from the uterus, miliary eruptions, or loose stools mixed with milk, which is curdled in the intestines; but should none of these evacuations happen, and the inflammation continue with increasing violence, there is danger of an imposthume, which is to be brought to maturity, and managed like other inflammatory tumors; and no astringents ought to be applied, lest they should produce scirrhus swellings in the glands.

As the crisis of this fever, as well as of that last described, often consists in miliary eruptions over the whole surface of the body, but particularly on the neck and breast, by which the fever is carried off, nothing ought to be given which will either greatly increase or diminish the circulating force, but such only as will keep out the eruptions. But if, notwithstanding these eruptions, the fever, instead of abating, is augmented, it will be necessary to diminish its force, and prevent its increase, by those evacuations we have mentioned above. On the contrary, should the pulse sink, the eruptions begin to retreat inwardly, and the moribund matter be in danger of falling upon the viscera, we must endeavour to keep them out by opiates and sudorific medicines; and here blisters may be applied with success.

CHAP. VI. Of the Evacuations necessary at the end of the Month after Delivery.

THOSE who have had a sufficient discharge of the lochia, plenty of milk, and suckle their own children, commonly recover with ease, and, as the superfluous fluids of the body are drained off at the nipples, seldom require evacuations at the end of the month; but if there are any complaints from fulness, such as pains and stitches, after the 20th day, some blood ought to be taken from the arm, and the belly gently opened by frequent glysters, or repeated doses of laxative medicines.

If the patient has tolerably recovered, the milk having been at first sucked or discharged from the nipples, and afterwards discussed, no evacuations are necessary

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before the third or fourth week; and sometimes not till after the first flowing of the menses, which commonly happens about the fifth week; if they do not appear within that time, gentle evacuations must be prescribed, to carry off the plethora, and bring down the catamenia.

Explana-
tion of the
Plates.

EXPLANATION OF THE PLATES.

Plate CCCXVI. fig. 1. represents a well formed pelvis.

AAAA, The *ossa ilia*, properly so called. *aa*, The iliac fossæ. *bbbb*, The angle which divides transversely and obliquely, from behind forward, the internal face of the os ilium into two parts, making part of the brim of the pelvis. *cccc*, The crista of the *ossa ilia*. *ee*, Their anterior superior spines. *ff*, The angle formed by the internal lip of the crista of the os ilium, to which is attached a ligament inserted at the other end in the transverse apophysis of the last lumbar vertebra. *gg*, The inferior angle of the os ilium, which makes part of the acetabulum.

BB, The os ischium. *bb*, Its tuberosities. *ii*, Its branches. *kk*, Its posterior part, making part of the acetabulum.

CC, The body of the os pubis. *ll*, Its angle. *mm*, Its posterior extremity, making part of the acetabulum. *nn*, Its descending branch, uniting with that of the ischium.

DDD, The os sacrum. 1, 2, 3, 4, The anterior holes. *ooo*, Its base. *pp*, The sides. *q*, The point. E, The coccyx. F, The last lumbar vertebra. *rr*, The transverse apophysis of that vertebra. *ss*, The ligament proceeding from the transverse apophysis of the last vertebra to the angle of the internal lip of the crista of the os ilium, marked *ff*. *tt*, Another ligament which descends from the same apophysis to the superior edge of the sacro-iliac symphysis.

GG, The femur or thigh-bone. VV, Its head received in the acetabulum. *u, u*, The foramina ovalia.

H, The symphysis of the *ossa pubis*. II, The sacro-iliac symphyses. K, The sacro-vertebral symphysis.

Fig. 2. represents the superior strait of a well formed pelvis.

aa, The iliac fossæ. *b*, The sacro-vertebral angle, or projection of the sacrum. *c*, The last lumbar vertebra. *dd*, The lateral parts of the base of the sacrum. *ee*, The sacro-iliac symphyses. *ff*, The parts over the acetabula. *g*, The symphysis of the pubes.

The lines denote the different diameters of the superior strait. AB, The little diameter. CD, The transverse or great diameter. EF, GH, The oblique diameter, extending from the left acetabulum to the right sacro-iliac junction.

Fig. 3. shows the inferior strait of a well formed pelvis.

aa, The external faces of the *ossa ilia*. *bb*, Their anterior superior spines. *cc*, Their anterior inferior spines. *dd*, The acetabula. *ee*, The foramina ovalia, with the obturator ligaments. *ff*, The ischiatic tuberosities. *gg*, The *ossa pubis*. *bb*, The branches of the os pubis and ischium united. *ii*, The sacrum. *k*, The coccyx. *ll*, The sacro-ischiatic ligaments. *m*, The symphysis of the pubes. *n*, Its arch.

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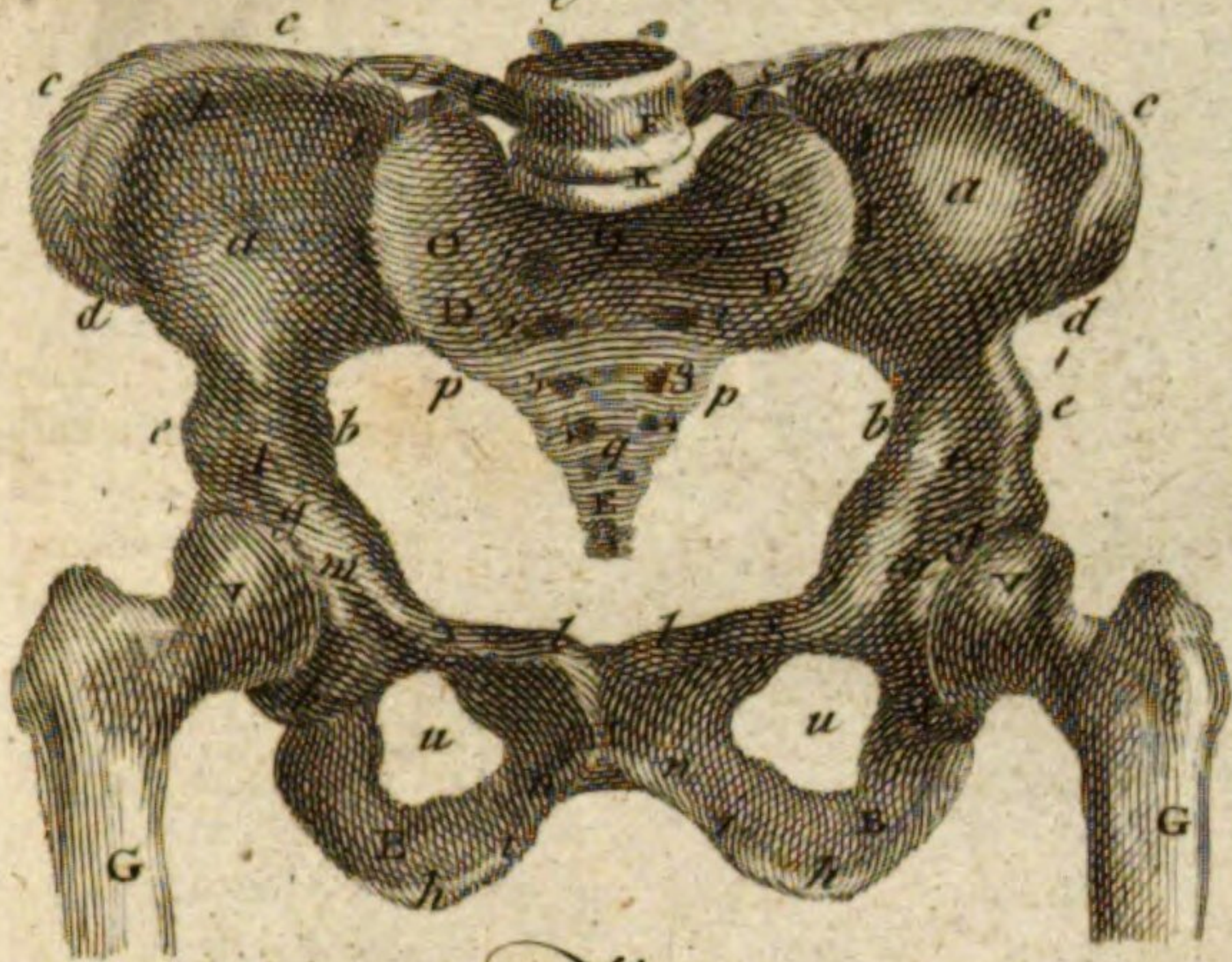


Fig. 2.

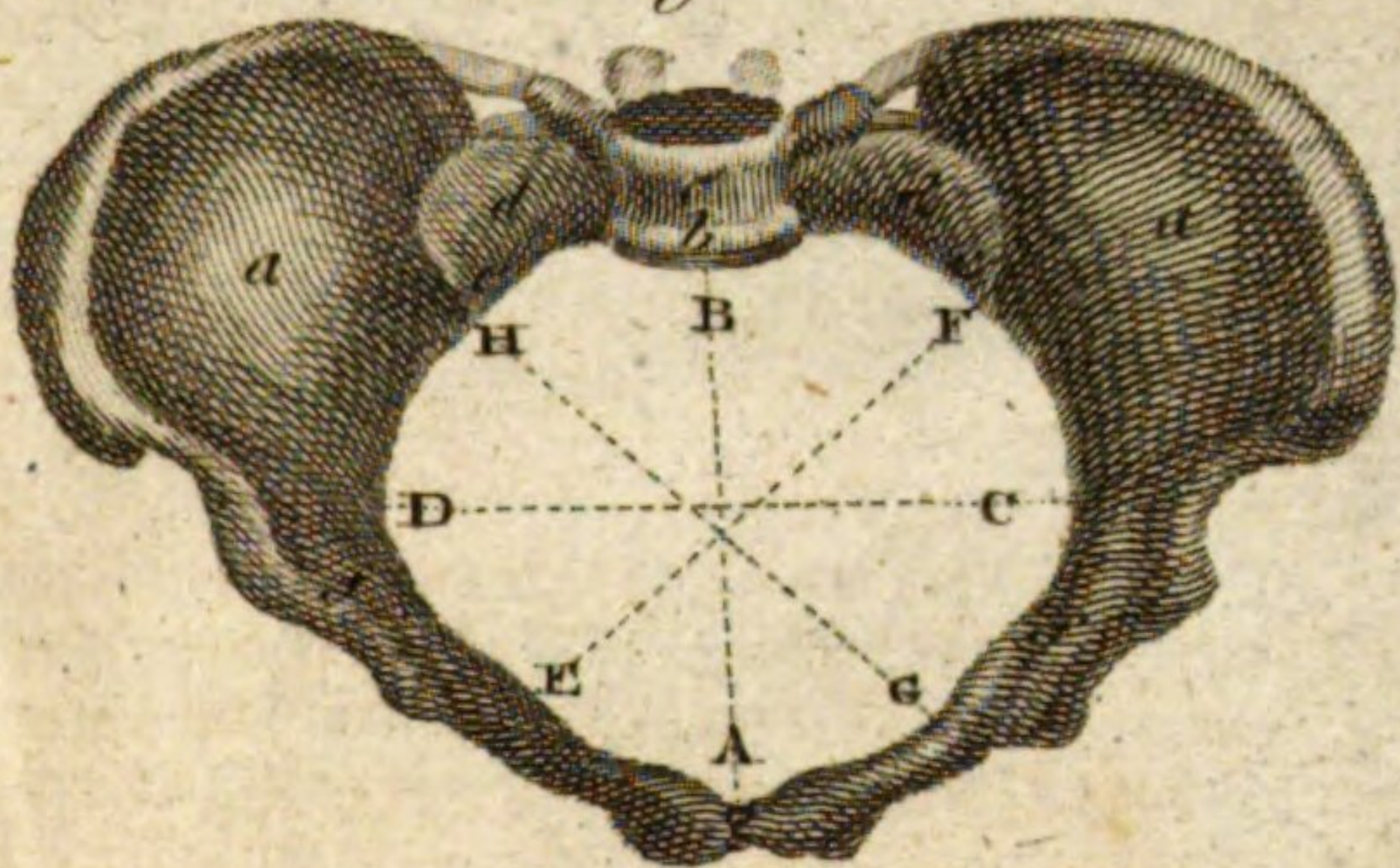


Fig. 3.

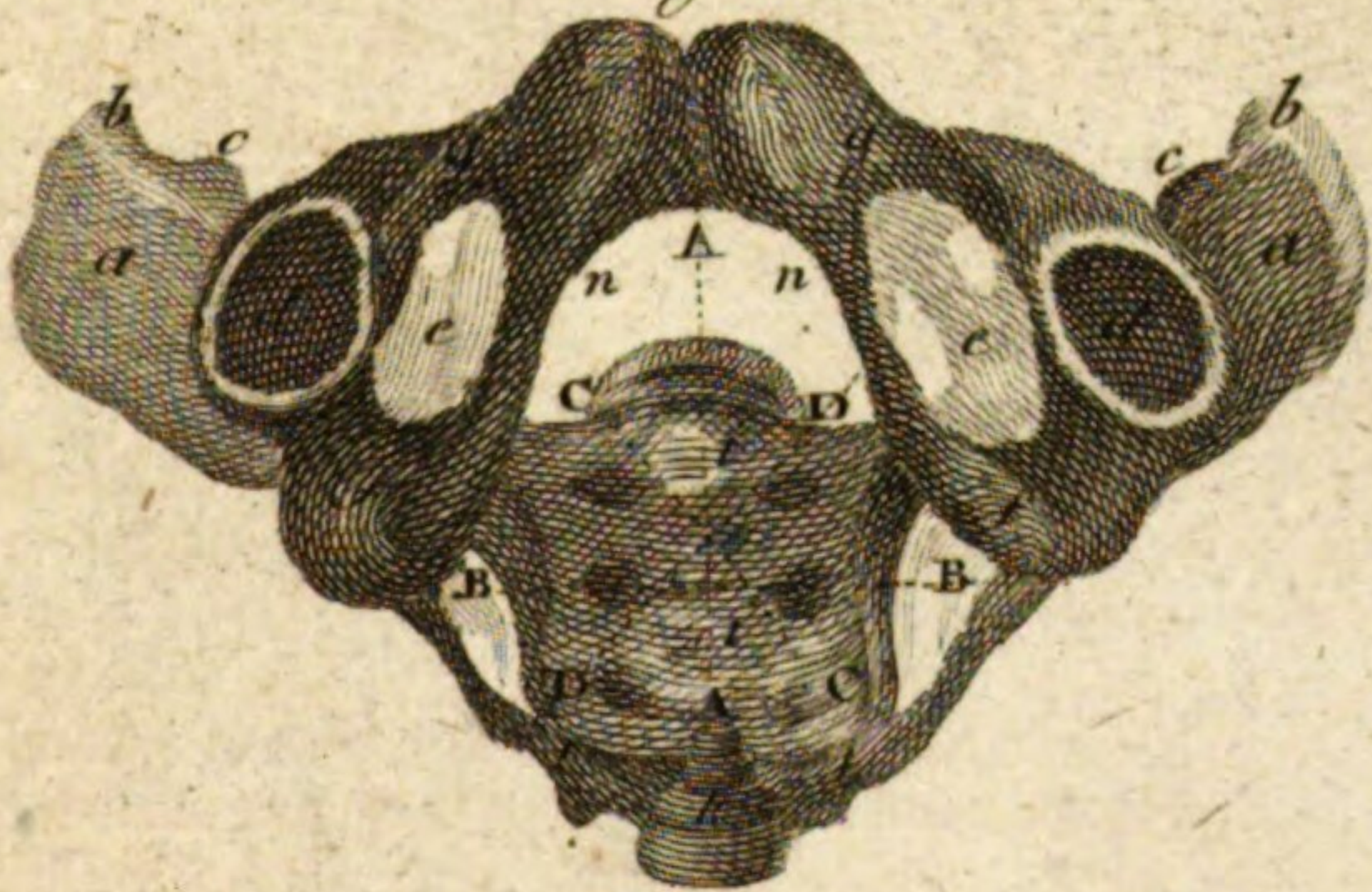


Fig. 8.

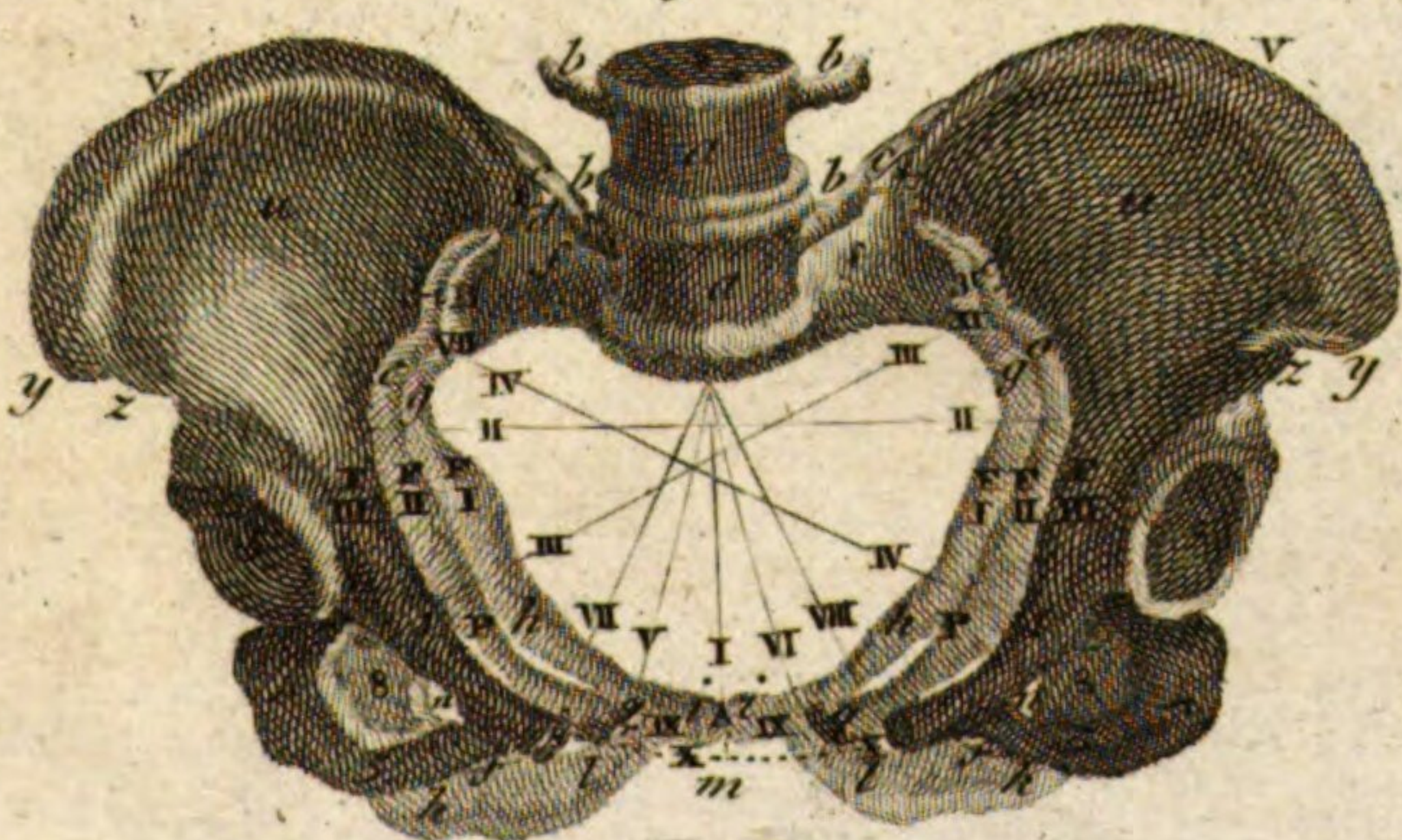


Fig. 4.

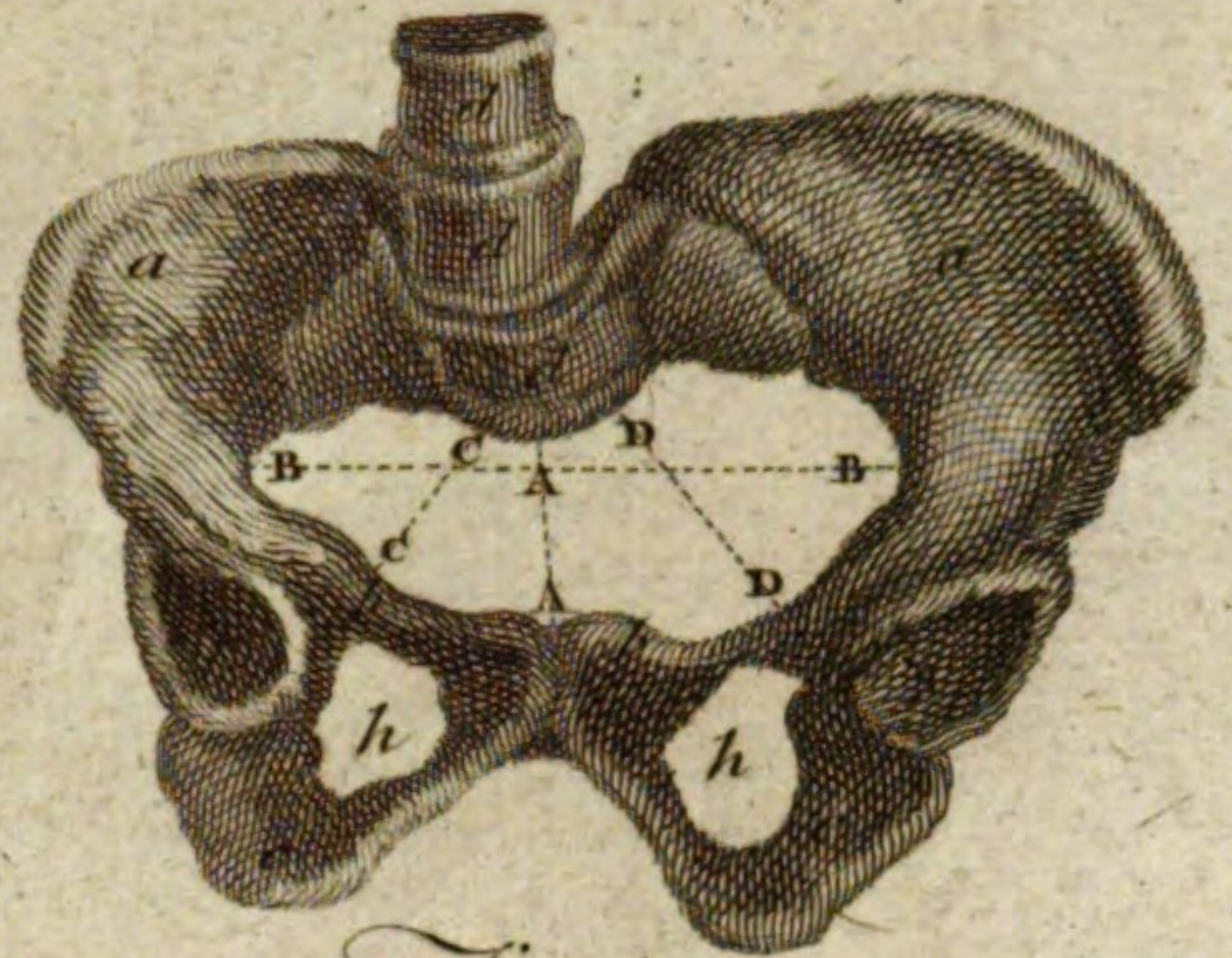


Fig. 5.

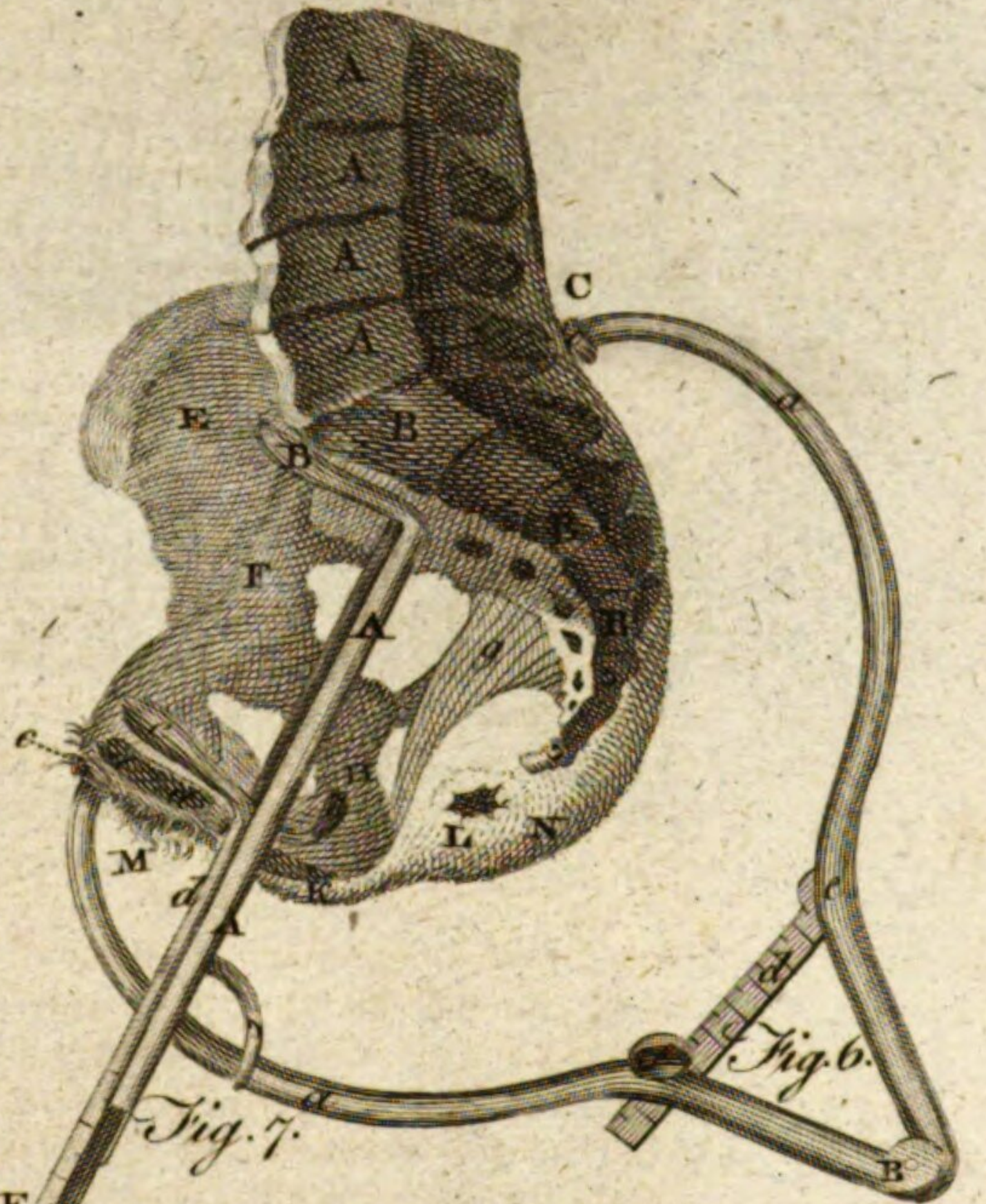
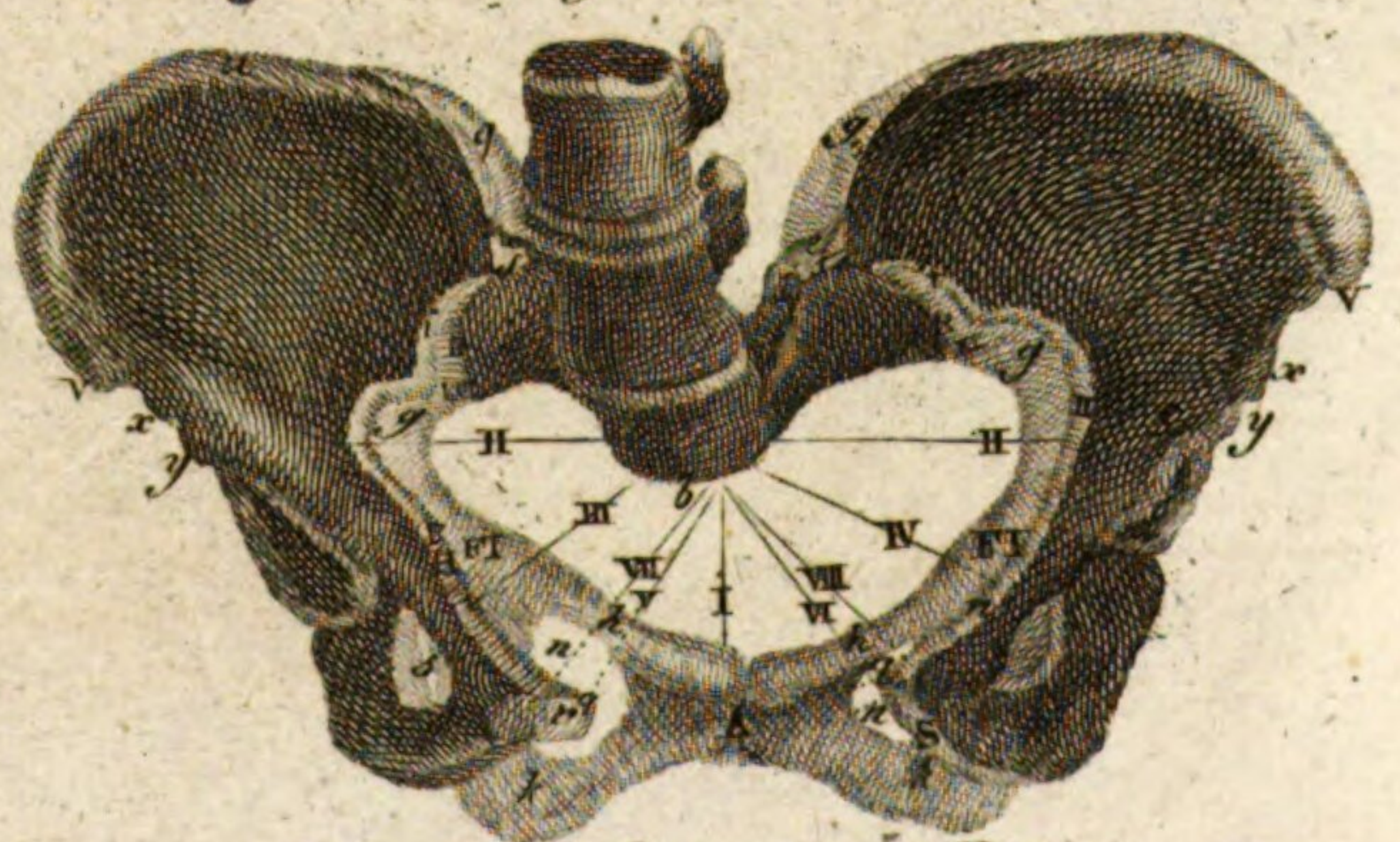


Fig. 7.

Fig. 6.

Fig. 9.



At Bell Pinn. Wal. Sculptor fecit.

Fig. 10.

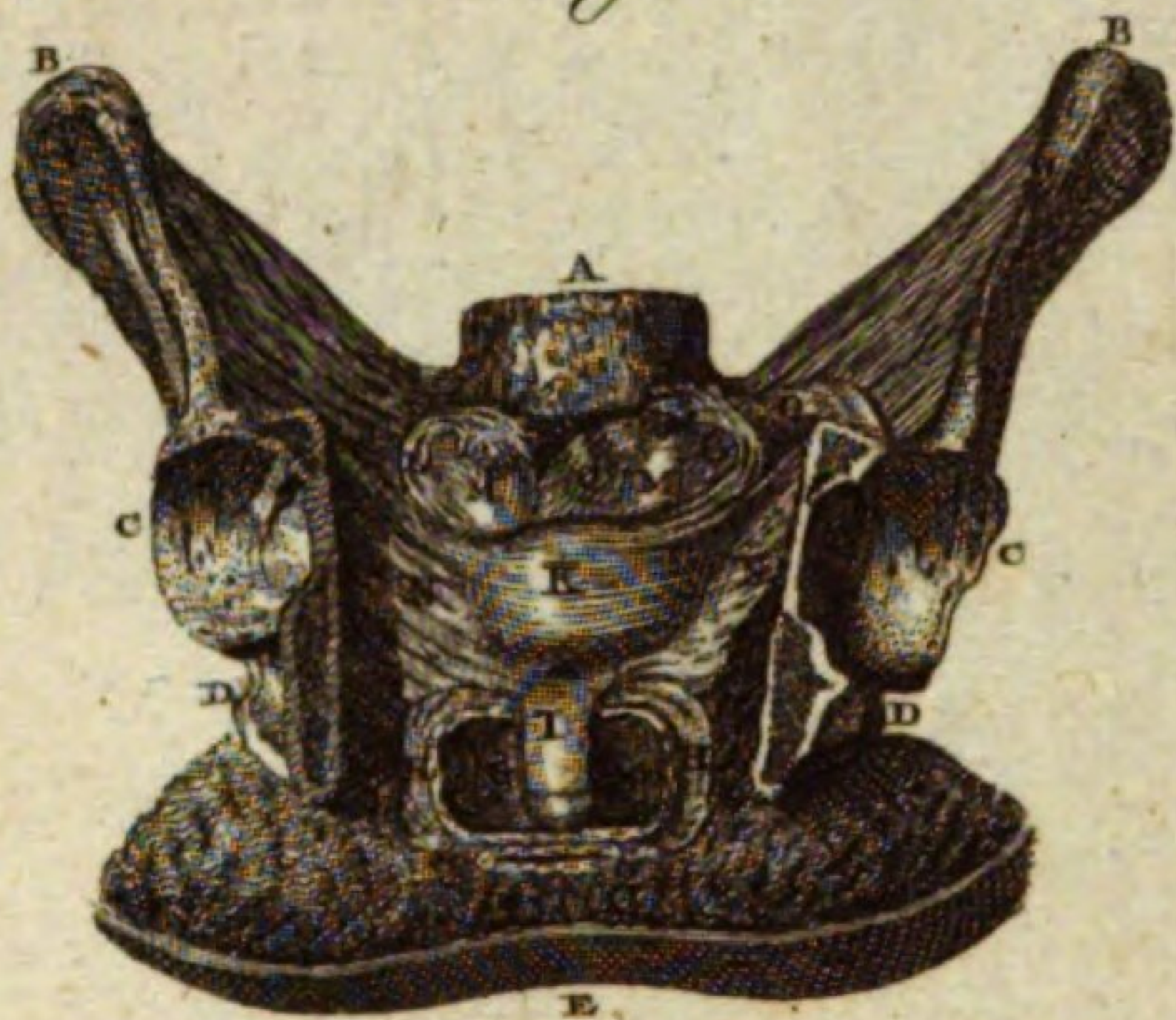


Fig. 11.



Fig. 13.



Fig. 12.



Fig. 14.

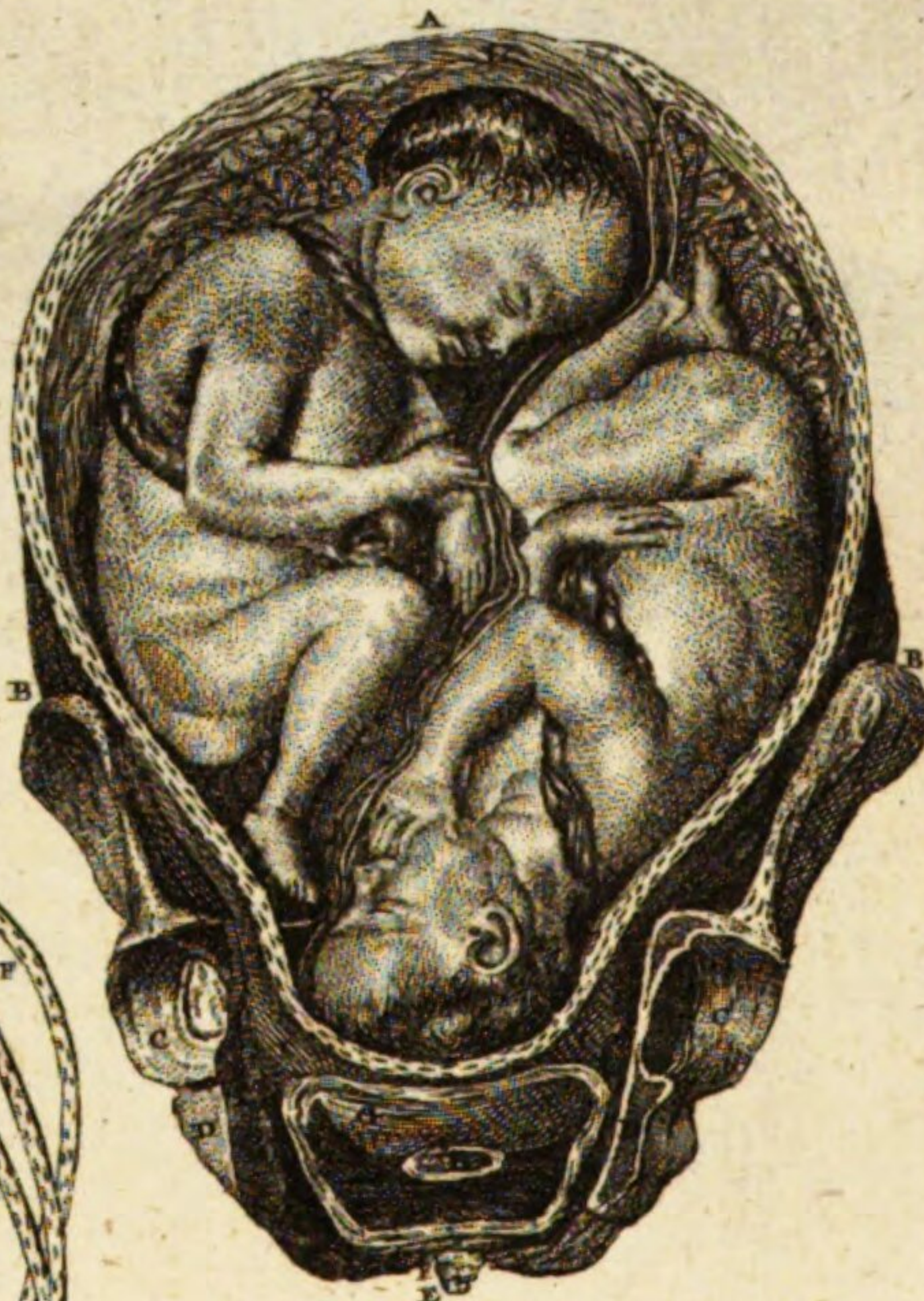


Fig. 15.

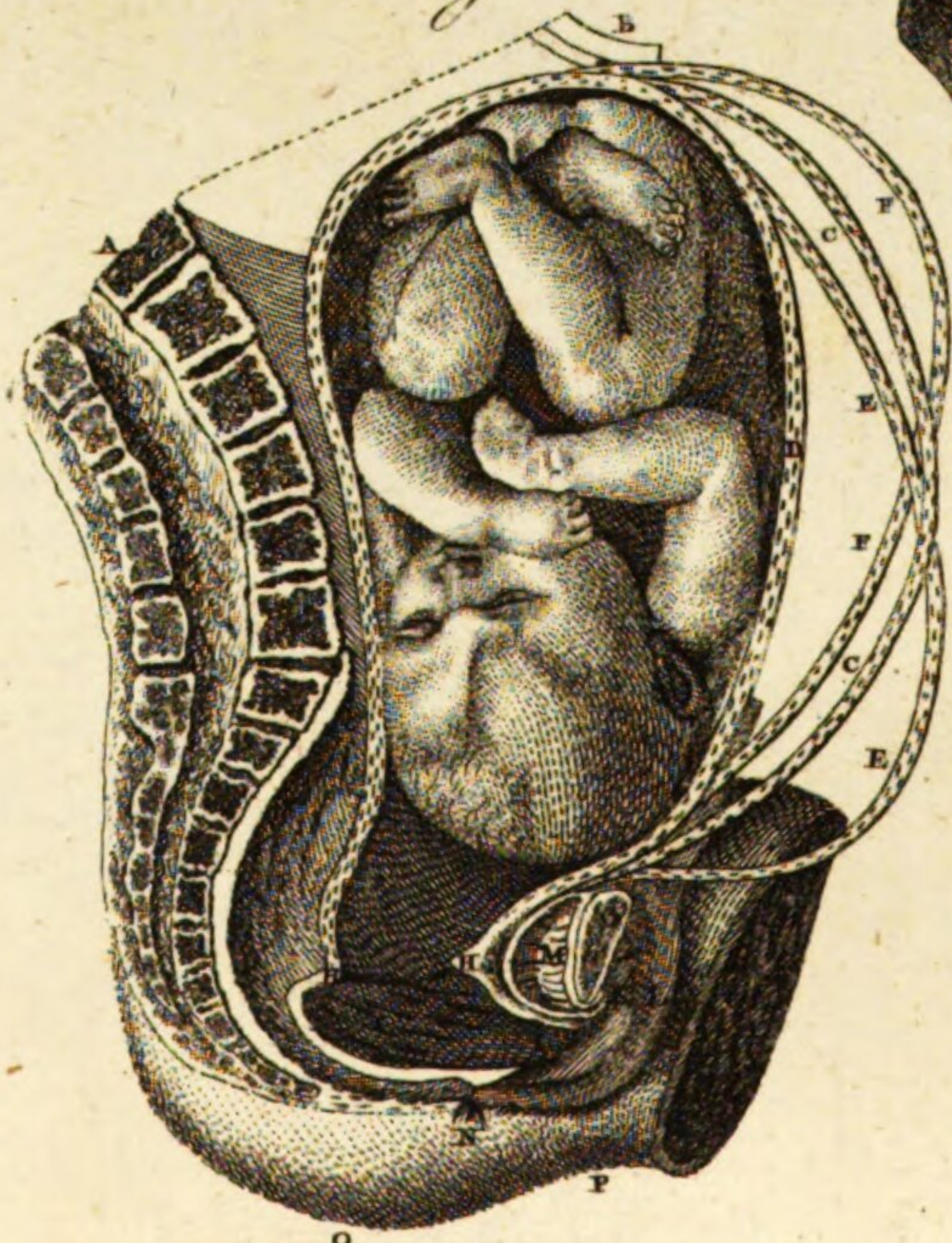
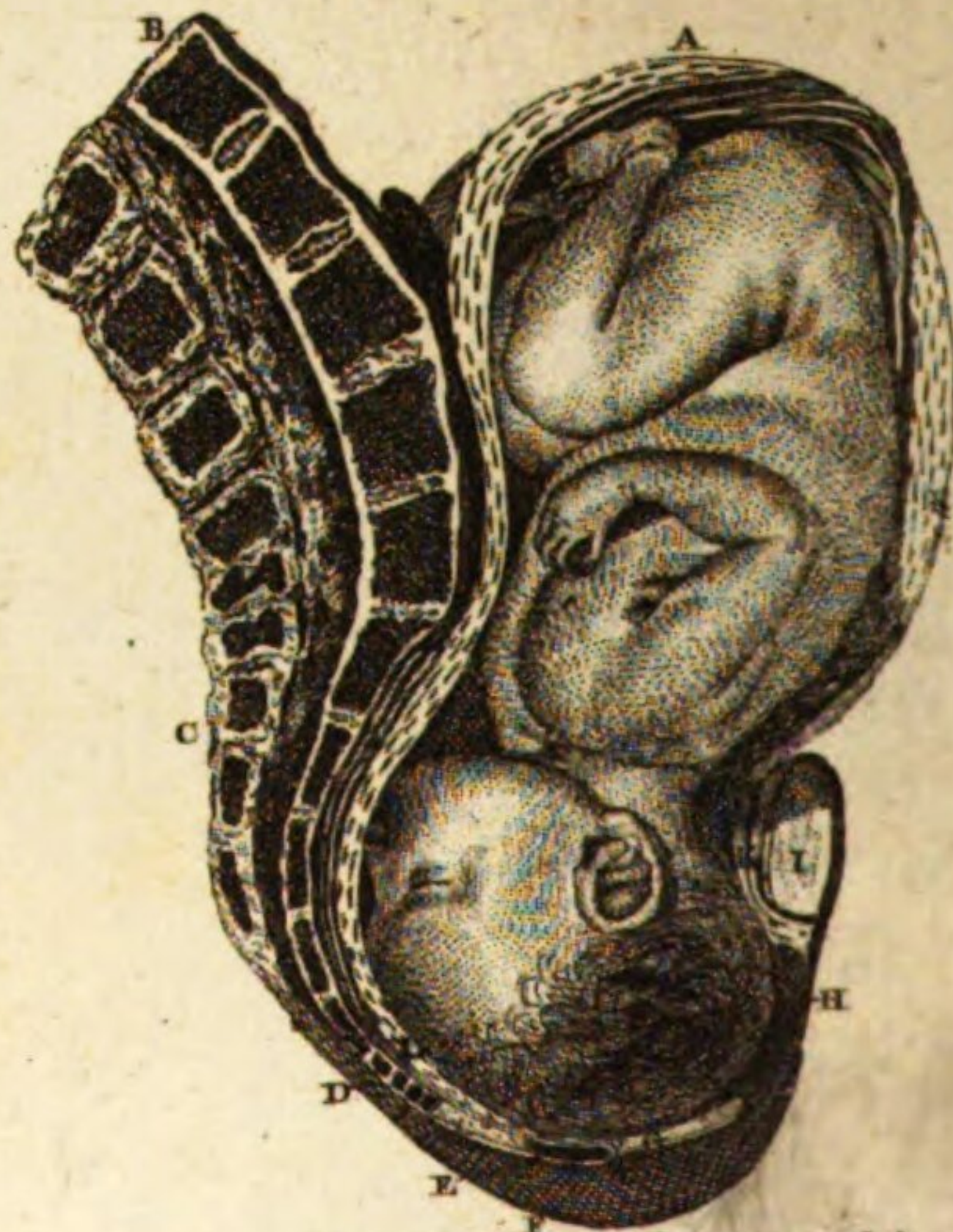


Fig. 16.



Explana-
tion of the
Plates.

The diameters of the inferior strait are marked by the lines. AA, The *antero-posterior*, or great diameter. BB, The transverse or little diameter. CC, DD, The oblique diameters.

Fig. 4. shows a deformed pelvis.

aa, The ossa ilia. bb, The ossa pubis. cc, The ossa ischia. ddd, The last lumbar vertebræ. e, The projection of the sacrum. ff, The sacro-iliac symphyses. g, The symphysis of the pubes. hh, The foramina ovalia. ii, The branches of the ossa pubis and ischia, which form the anterior arch of the pelvis. kk, The acetabula.

AA, The *antero-posterior* diameter; the natural length being 14 or 15 lines. BB, The transverse diameter; the natural length four inches and ten lines. CC, The distance from the projection of the sacrum to that point of the margin which answers to the left acetabulum, being 13 lines. DD, The distance from the same point of the sacrum to that of the margin which answers to the right acetabulum, 20 lines.

Fig. 5. shows a vertical section of the pelvis.

A, A, A, A, The four last lumbar vertebræ. B, B, B, The os sacrum. CC, The coccyx. dd, The surface resulting from the section of the symphysis of the pubes. E, The left iliac fossa. F, The left side of the superior strait. G, The sacro-ischiatic ligament. H, The tuberosity of the ischium.

ii, The entrance of the vagina. K, one of the labia pudendi. L, The anus. M, The mons veneris. N, The left natis.

Plate
CCCVII.

Fig. 10. gives a front-view of the uterus *in situ*, suspended in the vagina; the anterior parts of the ossa ischium, with the ossa pubis, pudenda, perinæum, and anus, being removed, in order to show the internal parts.

A, the last vertebra of the loins. BB, the ossa ilium. CC, the acetabula. DD, the inferior and posterior parts of the ossa ischium. E, the part covering the extremity of the coccyx. F, the inferior part of the rectum. GG, the vagina cut open longitudinally, and stretched on each side of the collum uteri, to show in what manner the uterus is suspended in the same.

HH, part of the vesica urinaria stretched on each side of the vagina, and inferior part of the fundus uteri.

I, the collum uteri. K, the fundus uteri. LL, the tubi Fallopiani and fimbriæ. MM, the ovaria. NN, the ligamenta lata and rotunda. OO, the superior part of the rectum.

Fig. 11. gives a front view of the uterus in the beginning of the first month of pregnancy; the anterior part being removed that the embryo might appear through the amnios, the chorion being dissected off.

A, the fundus uteri. B, the collum uteri, with a view of the rugous canal that leads to the cavity of the fundus. C, the os uteri.

Fig. 12. In the same view and section of the parts as in fig. 10. shows the uterus as it appears in the second or third month of pregnancy.

F, the anus. G, the vagina, with its plicæ.

HH, the posterior and inferior part of the urinary bladder extended on each side; the anterior and superior part being removed.

II, the mouth and neck of the womb, as raised up

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when examining the same by the touch, with one of the fingers in the vagina.

KK, the uterus as stretched in the second or third month, containing the embryo, with the placenta adhering to the fundus.

Fig. 13. In the same view and section of the parts with the former figures, represents the uterus in the eighth or ninth month of pregnancy.

A, the uterus as stretched to near its full extent, with the waters, and containing the foetus entangled in the funis, the head presenting at the upper part of the pelvis.

BB, the superior part of the ossa ilium. CC, the acetabula. DD, the remaining posterior parts of the ossa ischium. E, the coccyx. F, the inferior part of the rectum. GGG, the vagina stretched on each side. H, the os uteri, the neck being stretched to its full extent or entirely obliterated. II, part of the vesica urinaria. KK, the placenta, at the superior and posterior part of the uterus. LL, the membranes. M, the funis umbilicalis.

Fig. 14. gives a front view of twins *in utero* in the beginning of labour.

A, the uterus as stretched, with the membranes and waters. BB, the superior parts of the ossa ilium. CC, the acetabula. DD, the ossa ischium. E, the coccyx. F, the lower part of the rectum. GG, the vagina.

H, the os internum stretched open about a finger-breadth, with the membranes and waters, in time of labour pains.

II, the inferior part of the uterus, stretched with the waters which are below the head of the child that presents.

KK, the two placentas adhering to the posterior part of the uterus, the two foetuses lying before them, one with its head in a proper position at the inferior part of the uterus, and the other situated preternaturally with the head to the fundus; the bodies of each are here entangled in their proper funis, which frequently happens in the natural as well as preternatural positions.

LLL, the membranes belonging to each placenta.

Fig. 15. shows, in a lateral view and longitudinal division of the parts, the gravid uterus when labour is somewhat advanced.

A, the lowest vertebra of the back; the distance from which to the last mentioned vertebra is here shown by dotted lines. CC, the usual thickness and figure of the uterus when extended by the waters at the latter end of pregnancy. D, the same contracted and grown thicker after the waters are evacuated. EE, the figure of the uterus when pendulous. FF, the figure of the uterus when stretched higher than usual, which generally occasions vomitings and difficulty of breathing. G, the os pubis of the left side. HH, the os internum. I, the vagina. K, the left nympha. L, the labium pudendi of the same side. M, the remaining portion of the bladder. N, the anus. OP, the left hip and thigh.

Fig. 16. shows the forehead of the foetus turned backwards to the os sacrum, and the occiput below the pubes, by which means the narrow part of the head is to the narrow part of the pelvis, that is, between the inferior parts of the ossa ischium.

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A, the uterus contracted closely to the foetus after the waters are evacuated. BCD, the vertebræ of the loins, os sacrum, and coccyx. E, the anus. F, the left hip. G, the perinæum. H, the os externum beginning to dilate. I, the os pubis of the left side. K, the remaining portion of the bladder. L, the posterior part of the os uteri.

Fig. 17. is principally intended to show in what manner the perinæum and external parts are stretched by the head of the foetus, in a first pregnancy, towards the end of the labour.

A, the abdomen. B, the labia pudendi. C, the clitoris and its preputium. D, the hairy scalp of the foetus, swelled at the vertex, in a laborious case, and protruded to the os externum. E, F, the perinæum and anus pushed out by the head of the foetus in form of a large tumor. GG, the parts that cover the tuberosities of the ossa ischium. H, the part that covers the os coccygis.

Fig. 18. shows in what manner the head of the foetus is helped along with the forceps, as artificial hands, when it is necessary for the safety of either mother or child.

AABC, the vertebræ of the loins, os sacrum, and coccyx. D, the os pubis of the left side. E, the remaining part of the bladder. FF, the intestinum rectum. GGG, the uterus. H, the mons veneris. I, the clitoris, with the left nymph. X, the corpus cavernosum clitoridis. V, the meatus urinarius. K, the left labium pudendi. L, the anus. N, the perinæum. QP, the left hip and thigh. R, the skin and muscular parts of the loins.

Fig. 19. shows the head of the foetus, by strong labour-pains, squeezed into a longish form, with a tumor on the vertex, from a long compression of the head in the pelvis.

K, the tumor on the vertex. L, the forceps. M, the vesica urinaria much distended with a large quantity of urine from the long pressure of the head against the urethra. N, the under part of the uterus. OO, the os uteri.

Fig. 20. shows, in the lateral view, the face of the child presenting and forced down into the lower part of the pelvis, the chin being below the pubes, and the vertex in the concavity of the os sacrum: the water being likewise all discharged, the uterus appears closely joined to the body of the child.

Fig. 21. shows, in a lateral view, the head of the child in the same position as in the former figure.

AB, the vertebræ of the loins, os sacrum, and coccyx. C, the os pubis of the left side. D, the inferior part of the rectum. E, the perinæum. F, the left labium pudendi. GGG, the uterus.

Fig. 22. gives a lateral internal view of a distorted pelvis, divided longitudinally, with the head of a foetus of the seventh month passing the same.

ABC, the os sacrum and coccyx. D, the os pubis of the left side. E, the tuberosity of the os ischium of the same side.

Fig. 23. gives a side view of a distorted pelvis, divided longitudinally, with the head of a full grown foetus squeezed into the brim, the parietal bones decussating each other, and compressed into a conical form.

ABC, the os sacrum and coccyx. D, the os pubis

of the left side. E, the tuberosity of the os ischium. F, the processus acutus. G, the foramen magnum.

Fig. 24. shows, in a front view of the pelvis, the breech of the foetus presenting, and dilating the os internum, the membranes being too soon broke.

Fig. 25. is the reverse of the former, the fore-parts of the child being to the fore part of the uterus.

Fig. 26. represents, in a front view of the pelvis, the foetus compressed, by the contraction of the uterus, into a round form, the fore-parts of the former being towards the inferior part of the latter, and one foot and hand fallen down into the vagina. In this figure, the anterior part of the pelvis is removed, by a longitudinal section through the middle of the foramen magnum.

AA, the superior parts of the ossa ilium. BB, the uterus. C, the mouth of the womb stretched and appearing in OOOO, the vagina. D, the inferior and posterior part of the os externum. EEEE, the remaining part of the ossa pubis and ischium. FFFF, the membrana adiposa.

Fig. 26. represents, in the same view with fig. 27. the foetus in the contrary position; the breech and fore-parts being towards the fundus uteri, the left arm in the vagina, and the fore-arm without the os externum, the shoulder being likewise forced into the os uteri.

Plate CCCVI. fig. 8. shows a deformed pelvis of which the small diameter of the superior strait is only 2 inches seven lines. The figure is triple: F. I. shows it in its natural state; F. II. the ossa pubis separated 18 lines; and F. III. with a separation of two inches and an half, in order to show the quantity of amplification which the section of the symphysis in such a pelvis can produce.

F. I. *aa*, the two last lumbar vertebræ; *bbbb*, the transverse apophyses of these vertebræ; *cc*, ligaments proceeding from the transverse apophyses of the last of these vertebræ to the middle and posterior part of the internal lip of the crista of the os ilium; *dd*, other ligaments descending from the same apophyses to the superior part of the sacro-iliac symphyses; *e*, the projection of the sacrum; *ff*, the lateral parts of the base of the sacrum; *gg*, part of the ossa ilia: the rest of those bones being concealed by F. II. and III.

bb, The bodies of the ossa pubis; *ii*, their angles. *kk*, The ossa ischia; *ll*, the branches of these bones, and of the pubes.

m, The arch of the ossa pubis at the fore part of the pelvis.

nn, The foramina ovalia concealed by the ossa pubis of F. II. and III.

A, The symphysis of the ossa pubis seen perspective. BB, the sacro-iliac symphyses.

F. II. *oo*, Part of the ossa ilia.

PP, The bodies of the ossa pubis; *qq*, their angles; *rr*, their articular facettes seen perspective; *ss*, very small portions of the branches of the ossa pubis.

ss, The ossa ischia appearing behind the foramina ovalia of n^o III; *tt*, articular facettes of the ossa ilia, corresponding to similar ones observed at the sides of the sacrum.

F. III. *uu*, The ossa ilia; *vv*, their crista; *xx*, the angle formed by the internal lip of the crista in the middle and posterior part of its length; *yy*, the anterior and

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Fig. 17.

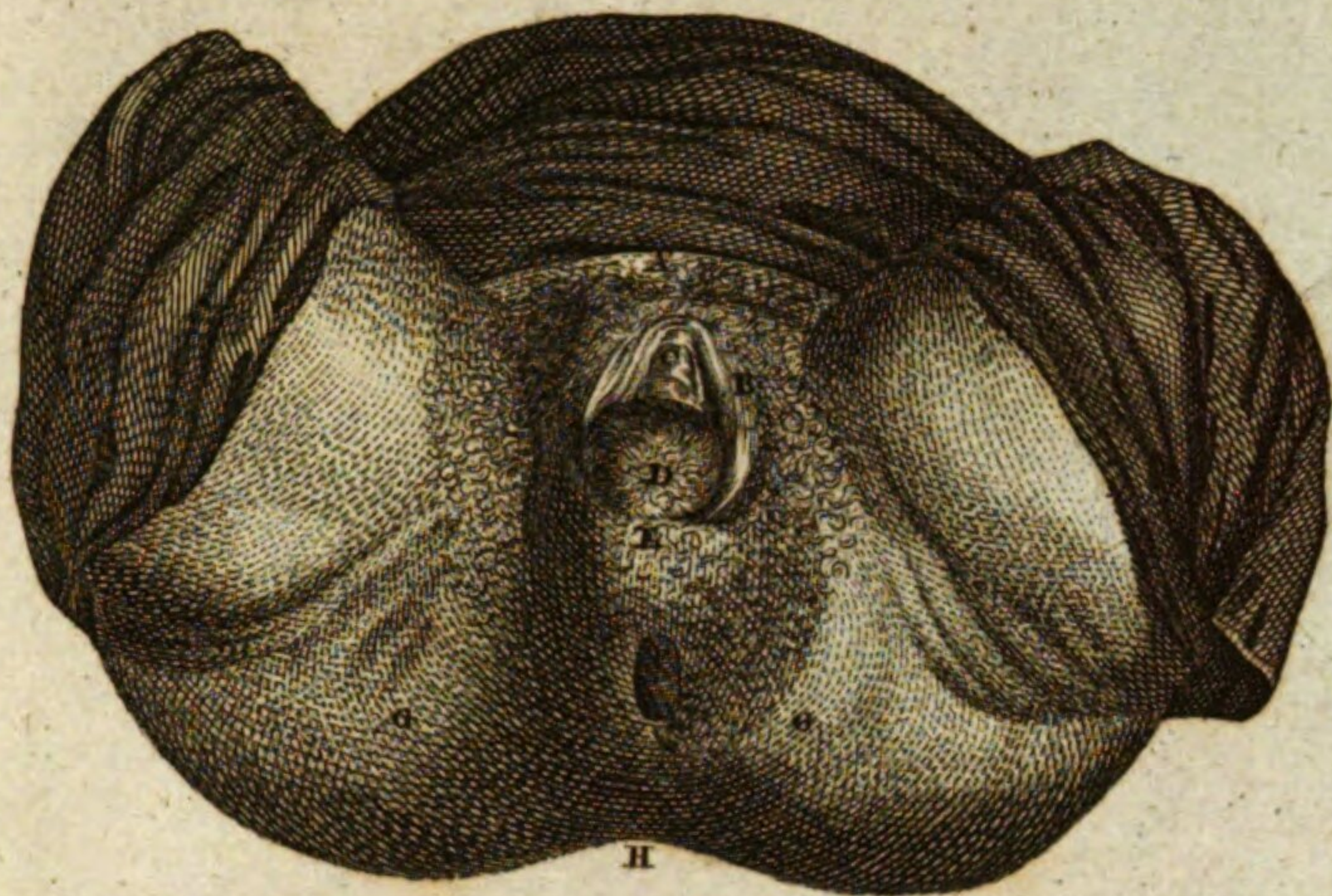


Fig. 18.

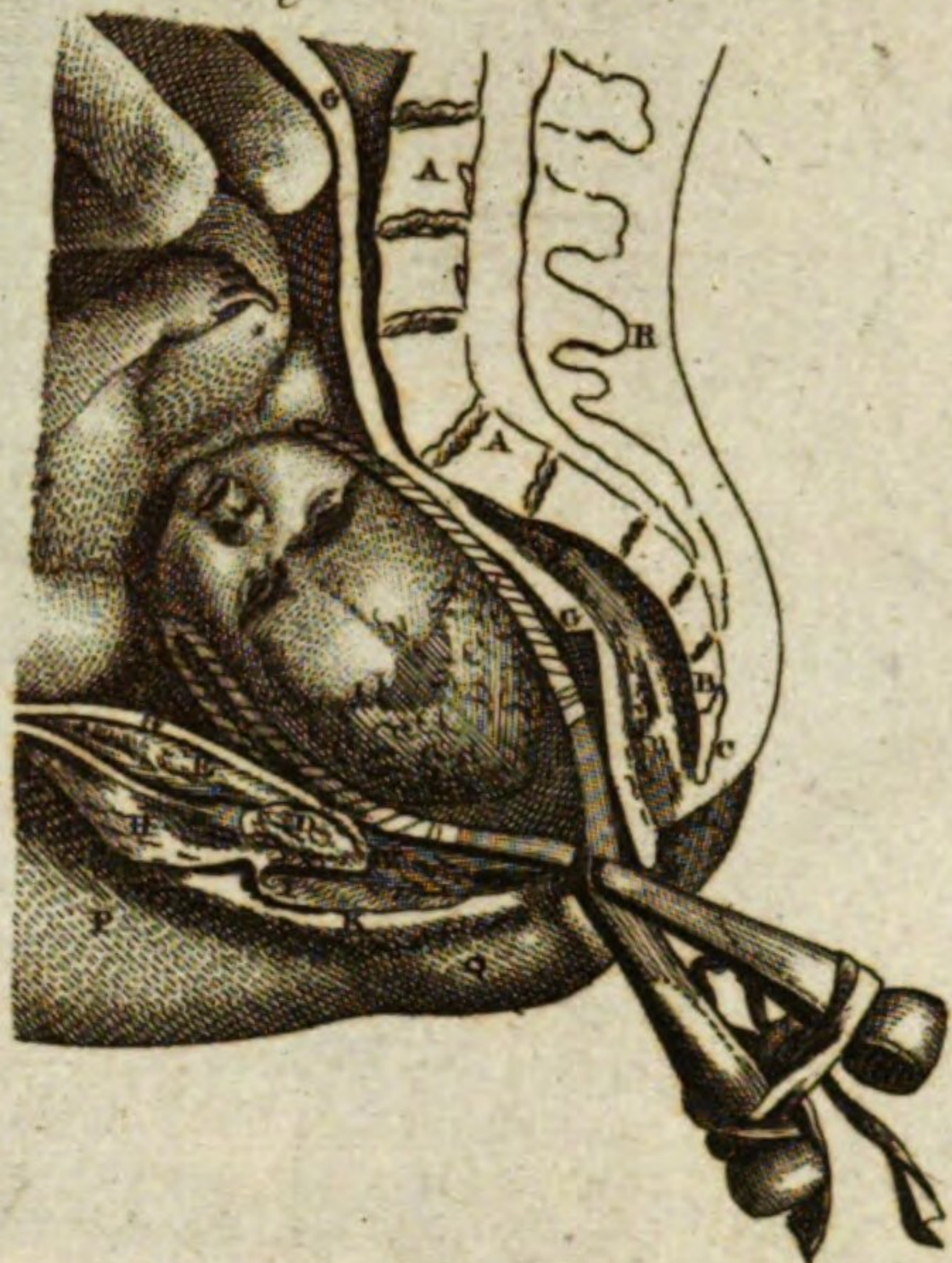


Fig. 19.

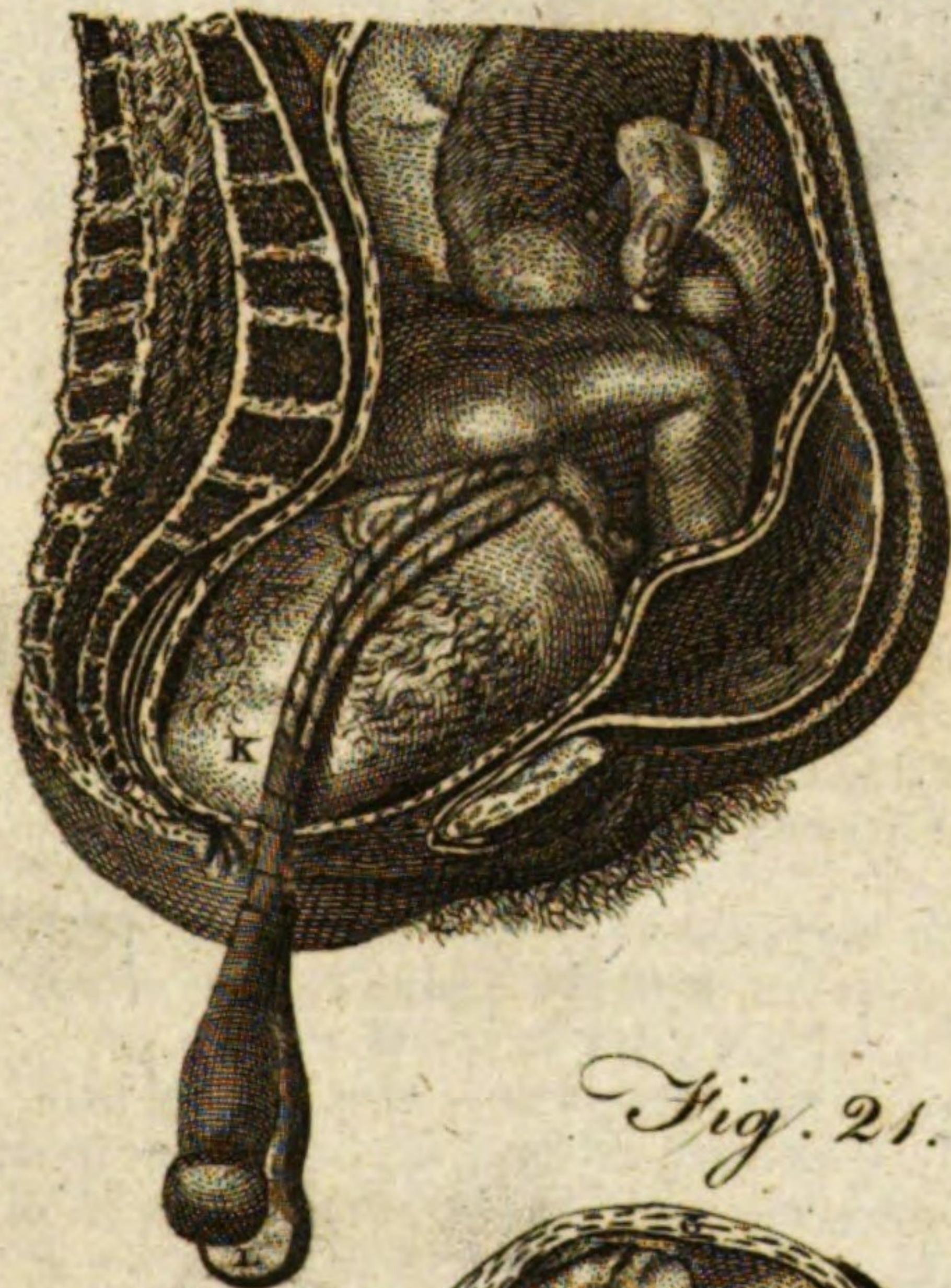


Fig. 20.

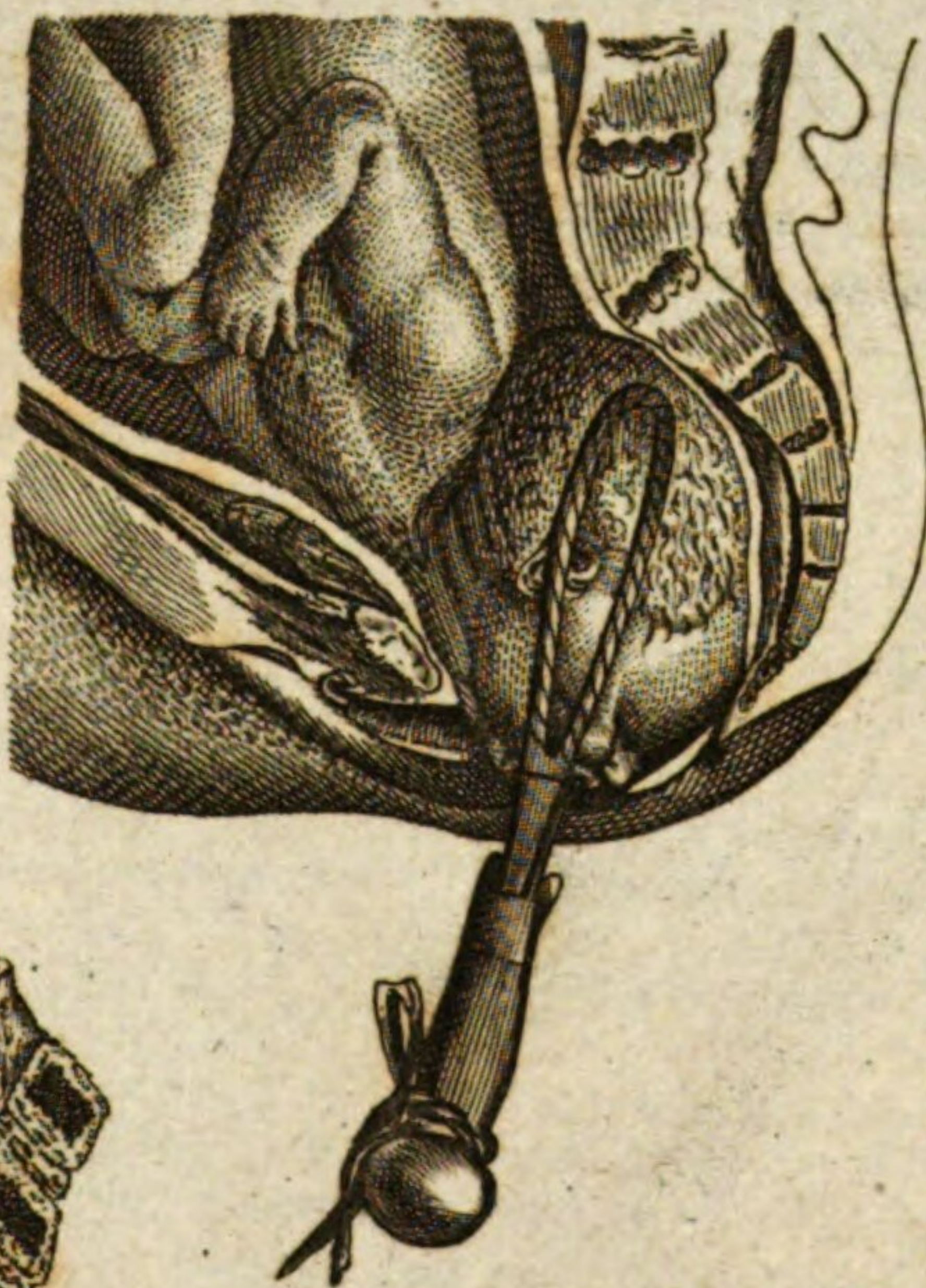


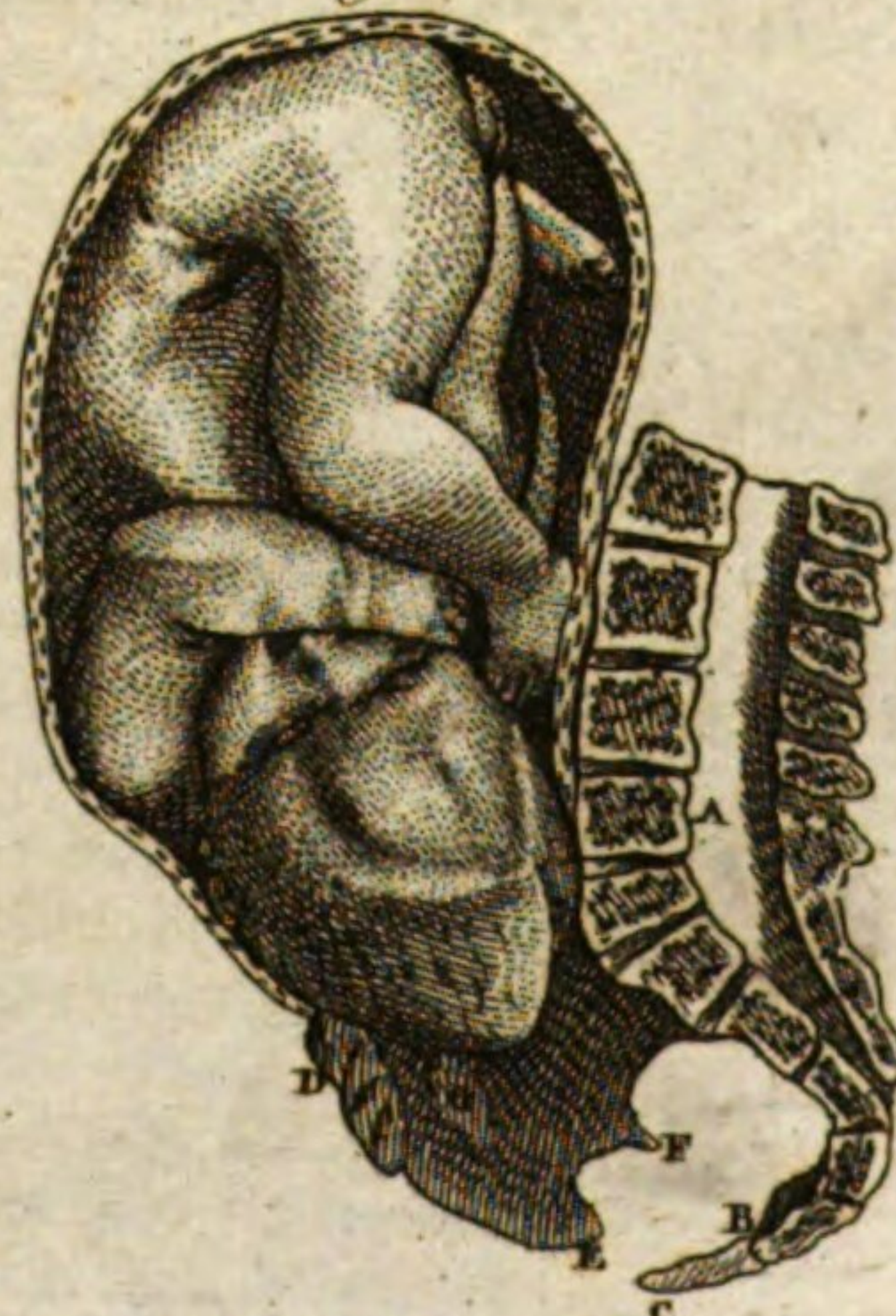
Fig. 22.



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superior spines of the ossa ilia; *z z*, the anterior spines of these bones; *U U*, articular facettes of the ossa ilia, making part of the sacro-iliac symphyses.

1 1, The ossa pubis; 2 2, their angles; 3 3, their articular facettes seen perspective.

4 4, The ossa ischia; 5 5, the united branches of the ossa ischia and pubis; 6 6, the acetabula.

The lines indicate the natural size of the pelvis in the different directions in which they are traced; and their dotted extremities, the amplification which the superior strait acquires in those same directions at a separation of eighteen lines, and of thirty lines between the ossa pubis. Line I. Antero-posterior diameter of the superior strait, or the distance from the pubes to the projection of the sacrum; two inches seven lines. Line II. Transverse diameter of the superior strait, in its most extensive part; four inches seven lines. Line III. Oblique diameter of the superior strait, which extends from that point of the strait which corresponds with the anterior edge of the left acetabulum, to the right sacro-iliac junction; three inches eleven lines. Line IV. The other oblique diameter, which extends from that point of the strait which answers to the anterior edge of the right acetabulum, to the left sacro-iliac symphysis; four inches.

By giving the smallest attention to the relation of these dimensions to those which the head of a fœtus of the usual size presents in their direction in time of labour, we shall see that they are very favourable; except the first, which is, strictly speaking, eleven lines too short, being only thirty-one lines in extent: whereas the transverse diameter of the head is commonly forty-two. It is only in this latter direction, and to the extent of eleven lines, that it would be necessary to augment the capacity of such a pelvis, to favour delivery. As the greater part of those who have performed this new operation, have only obtained a separation of eighteen lines or thereabouts between the ossa pubis, it is fixed at that degree in the second figure.

By such a separation in a pelvis perfectly similar to that here represented, the angle of each os pubis recedes from the centre of the projection of the sacrum three lines or very near beyond their natural distance from it. (See the lines V. and VI). The antero-posterior diameter receives but the same increase, if we consider it as lengthened to the middle of the dotted line IX. IX. which marks the depth at which it may be presumed the lateral convexity of the head engages. Both the oblique diameters augment five lines before, and about two lines and an half backward; and the transverse diameter seven lines or very nearly.

It is evident, that a separation of eighteen lines on such a pelvis cannot remove the disproportion which exists between the small diameter of the superior strait and the small diameter of the child's head; since the former augments only three lines, considered in the most favourable point of view. The amplification which the other diameters receive from a similar separation, is absolutely useless; those diameters being naturally large enough.

Supposing that the ossa pubis recede in an equal degree, in separating two inches and an half, the angle

of each of them will remove from the centre of the projection of the sacrum, only six lines farther than the distance they were from it before; which also gives an increase of but six lines between these two points. (See the lines VII. and VIII). The small diameter of the entrance of the pelvis does not gain much more, considering it to the middle of the dotted line XX. which marks the bounds beyond which the convexity of the head could not engage between the ossa pubis, even if the pelvis were divested of all its soft parts: which does not happen in the section of the pubes, for the neck of the bladder, the canal of the urethra, their cellular tissue, the anterior semicircle of the orifice of the uterus, and the anterior part of the vagina present at the opening and before the child's head. At this degree of separation, the transverse diameter augments about thirteen lines, and each oblique diameter nearly fourteen lines: a superfluous increase, since those diameters, in the pelvis represented, have all the length requisite for delivery.

The posterior extremities of the oblique diameters, which are dotted and marked with the figures XI and XII, show the separation which is to be feared in the sacro-iliac symphyses, by separating the ossa pubis two inches and an half. It was at that degree that Mr Baudelocque observed they were open in most of his experiments; since he could easily put the end of his finger, and even of his thumb, into them.

Admitting that the convexity of one of the sides of the child's head may let itself in between the ossa pubis separated to two inches and an half, as far as the dotted line XX, traced on that very convexity, it is evident that that separation cannot procure the relation of dimensions necessary for an easy delivery, when the pelvis has originally but two inches six or seven lines in the small diameter: whence it follows that the section of the pubes, supposing that we could obtain a separation of two inches and an half in the living woman without exposing her to disagreeable accidents, would not answer in the case of a pelvis similar to that represented in this plate.

Fig. 9. shows a pelvis with only 14 or 15 lines in the small diameter of its entrance, and four inches ten lines in the largest. The figure is triple like the former. F. I. represents it in its natural situation; F. II. with the ossa pubis separated two inches and a half; and F. III. with a separation of three inches. M. le Roy says, that he constantly obtained these two degrees of separation without any inconvenience.

F. I. *aaa*, The three last lumbar vertebræ. *b*, The projection formed by the last of those vertebræ, with the base of the sacrum. *cc*, The sides of the base of the sacrum. *ddd*, The transverse apophyses of the right side of the above-mentioned vertebræ. *ee*, A ligament extending from the first of those apophyses to the angle made by the internal lip of the crista of the os ilium towards its middle and posterior part. *ff*, Another ligament which depends from that apophysis to the superior part of the sacro-iliac symphysis. *gggg*, Part of the os ilium. *hh*, The bodies of the ossa pubis: *ii*, their angles. *kk*, The ossa ischia. *ll*, The branches of the ossa ischia and pubis. *m*, The arch of the ossa pubis. *nn*, The foramina ovalia. *A*, the symphysis of the ossa pubis. *BB*, The sacro-iliac symphyses.

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F. II. *oooo*, Part of the ossa ilia. *ss*, The articular facettes of the ossa ilia, making part of the sacro-iliac symphyses. *pp*, The bodies of the ossa pubis. *qq*, The angles of the ossa pubis separated two inches and an half. *rr*, The cartilaginous facettes of the ossa pubis seen perspectively. *ss*, The branches of the ossa ischia and pubes.

F. III. *tt*, The ossa ilia: *uu*, their cristæ: *vv*, their anterior superior spines: *xx*, their anterior inferior spines.

yy, The anterior inferior spines of the ossa ilia of F. II. *zz*, Their anterior articular facettes, making part of the sacro iliac symphysis.

ææ, The bodies of the ossa pubis: *11*, their angles. *22*, The articular facette of each os pubis seen perspectively. *33*, The united branches of the ossa pubis, and ischia seen perspectively.

44, The ossa ischia. *55*, The foramina ovalia, behind which is seen part of the ossa ischia of F. II. *66*, The acetabula.

The lines indicate the length of the different diameters of the superior strait, in the direction in which they are traced; and their dotted extremities, the amplification to be expected from a separation of two inches and an half, and of three inches.

Line I, The antero-posterior, or small diameter of the superior strait; one inch two or three lines. Line II, The transverse diameter of the same strait: this line, which is four inches ten lines in extent, passes under the projection of the sacrum. Line III, The distance from the middle and left lateral part of the projection of the sacrum, to that point of the margin of the pelvis which answers to the anterior edge of the acetabulum on the same side; one inch. Line IV, The distance from the middle and right lateral part of the projection of the sacrum, to that point of the margin which answers to the anterior edge of the acetabulum on the same side; one inch eight lines.

The relation of these dimensions to those of a child's head of the usual size, is such, that the small diameter of the latter, supposed always to be three inches and an half, surpasses the small diameter of the entrance of such a pelvis by 27 or 28 lines. This pelvis would be large enough in the direction of the line II, II.

By separating the ossa pubis two inches and an half, we augment the breadth of the entrance of the pelvis about three quarters of an inch in the direction of the line II, II: as much, or nearly in the direction of the line III, and only six lines in that of the line IV. The angle of each os pubis marked by the letter *q*, recedes from the centre of the projection of the sacrum, nine or ten lines beyond what it was distant from it before the separation of the bones: the entrance of the pelvis increases as much in the direction of the line V, and only half an inch in the course of the line VI. The small diameter, or the line I, continued to the middle of the dotted line IX, IX, which shows the depth to which the child's head may be let in between the ossa pubis separated two inches and an half, if the pelvis were divested of all its soft parts: this diameter will then be augmented only seven lines; whence we see that it would still be

an inch and an half, at least, shorter than the small diameter of the head of a child of the usual size.

The section of the pubes would therefore be fruitless on such a pelvis, if it could only procure a separation of two inches and an half; which seems a very exorbitant one. With more reason would it be unsuccessful, if we could separate the ossa pubis only 18 lines, as has most frequently happened; since it could not procure the proportion necessary for delivery, even if we could turn that separation entirely to the advantage of the small diameter of the superior strait.

Let us see if a separation of three inches could procure that proportion.

By separating the ossa pubis three inches, we augment the breadth of the pelvis 12 or 13 lines in the direction of the line II, II; 10 lines at most in the course of the line III; only seven in the line IV; about an inch in the line V; and only seven lines in the direction of the line VI: the angle of each os pubis recedes an inch farther from the projection of the sacrum, than the distance it was at before the separation of the bones; which augments the opening of the pelvis to the amount of an inch or thereabouts in the direction of the line VII, and only half an inch in the line VIII. The antero-posterior diameter of the entrance of this pelvis, considered as far as the middle of the dotted line X, X, which shows the greatest depth to which the child's head could be let in between the ossa pubis separated three inches, if the pelvis were divested of the soft parts, increases but 10 lines or thereabouts; which cannot remove the disproportion that existed before the section of the pubes, between that diameter and the thickness of the child's head which must pass in that direction. From whence we ought to conclude that this separation also would have no success, if the pelvis were as much deformed as that designed.

The dotted lines XI and XII, show the separation to be feared in the sacro-iliac symphyses, by separating the ossa pubis three inches.

The two other dotted lines, marked by the characters IX, IX, and X, X, show how far the child's head may be let in between the ossa pubis separated to the two degrees stated: they were traced on the convexity of a real head applied behind the ossa pubis in a pelvis stripped of its soft parts.

Plate CCGX. fig. 29. shows a well formed pelvis, the anterior part of which is taken away, to show one of the transverse positions of the face of the child, and explain more fully the mechanism of that kind of labour.

a, a, Part of the iliac fossæ. *b, b*, Part of the cristæ of the ossa ilia. *c, c*, Their anterior superior spines.

d, d, The ischiatic tuberosities. *e, e*, The acetabula. *f, f*, The thickness of the ossa ischia sawn through vertically before their tuberosities.

g, g, The bodies of the ossa pubis sawn through before the acetabula.

h, h, h, A circle representing a vertical section of the uterus, the anterior part of which is taken away in order to show the child. *i*, The child's chin. *k*, The posterior extremity of the head. *l, l, l*, The lever applied along the crown of the head, the extremity of it extending beyond the posterior fontanella.

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m, The left lateral, and inferior part of the pelvis.
n, A portion of the right lateral part of the uterine cavity. *o*, The left hand. *p, q*, The fore and middle fingers, placed at the sides of the nose, and pressing against the upper jaw. *R*, The right hand grasping the extremity of the lever.

Fig. 30. shows the same vertical section of a pelvis as the last; with the child's body entirely disengaged from it. The head grasped by the forceps is retained at the superior strait, with the occiput over the pubes, and the lower part of the forehead against the projection of the sacrum.

a, a, The last lumbar vertebræ. *d, d*, The canal of these vertebræ, and of the sacrum. *g, g, g, g*, Spiny tubercles of the vertebræ above mentioned. *b, b, b, b*, The false vertebræ of the sacrum. *c, c, c*, The coccyx. *e, e*, The flattened portion of the anterior face of the sacrum.

f, The left sacro-ischiatic ligament. *h*, The cartilaginous and ligamentous facette of the left os pubis, making part of the symphysis.

i, The mons veneris. *k, k, k, k*, A circle representing the section of the uterus, the right side of which is taken away to show the head and the instrument. *l, l*, A portion of the placenta attached to the superior and anterior part of the uterus.

m, m, m, The female branch of the forceps applied on the left side of the head, which answers to the right side of the pelvis. *n, n*, The male branch of the forceps, applied at the left side of the pelvis, and the right side of the head. *o*, Part of the left small sacro-ischiatic ligament. *P*, Part of the left os ilium, the rest being concealed by the head.

q, The point to which we ought to bring the lower extremity of the forceps, in bringing the head down into the cavity of the pelvis.

R, The point of elevation at which the extremity of the forceps must be held, when the head occupies the bottom of the pelvis, after having replaced the face underneath.

Fig. 31. shows also the vertical section of a pelvis; but it is supposed to have only three inches six lines in the small diameter of its entrance. The base of the cranium is engaged in it in a transverse direction, the occiput being turned towards the left side, and the face to the right side; so that the greatest thickness of the head is still above the strait.

a, a, The two last lumbar vertebræ. *b, b, b, b, b*, The five false vertebræ of the sacrum. *c, c, c*, The three pieces of the coccyx. *d, d*, The canal of the aforesaid vertebræ. *e, e, e, e*, Their spinous apophyses. *f, f*, Part of the anterior face of the sacrum.

g, The left sacro-ischiatic ligament. *h*, The cartilaginous and ligamentous facette of the left os pubis, making part of the symphysis. *i*, The mons veneris.

k, k, k, k, A circle indicating the section of the uterus in the same direction as that of the pelvis. *l, l*, A portion of the placenta attached to the fundus of the uterus.

m, m, m, The female branch of the forceps, applied on the left side of the child's head, and under the symphysis of the pubes. *n, n, n*, The female branch of the forceps applied on the right side of the head, and before the sacrum. *o*, A dotted line, in the direction of which the instrument must be pulled to

bring down the head into the pelvis. *p*, The point of elevation at which the forceps must be held when the head is brought down to the bottom of the pelvis, after having turned the face into the curve of the os sacrum.

Plate CCCVI. fig. 6. shows M. Baudelocque's calipers for measuring the antero-posterior diameter of the superior strait.

a, a, The branches of the calipers. *B*, The hinge which unites the two branches. *c, c*, Lenticular buttons which terminate the branches. *d*, A graduated scale nine inches long, intended to demonstrate the thickness of the body comprised between the two branches. This scale is contained in a deep groove cut lengthwise in the branch of the calipers, from the letter *e* to the hinge *B*; and passes through a mortoise made in the other branch under the letter *f*. *e*, The place where the scale is united by a kind of hinge. *f*, A little screw with a flat head, designed to fix the scale, while we calculate the thickness of the body comprised between the two branches.

Fig. 7. shows the pelvimeter of M. Coutonli developed in the pelvis.

A, A, The first branch; whose square, *B*, is applied to the projection of the sacrum. *C, c*, A kind of hooks intended to keep the first branch in its place, while we introduce and develop the second. This has a dove-tailed groove, in which the body of the second branch is lodged and moved. *d, d*, the second branch of the instrument, whose square *e* is placed against the symphysis of the pubes. *F*, a scale four inches long, graduated in the branch *d, d*; and intended to show the degree of opening from the pubes to the sacrum.

Plate CCCVIII. fig. 21. represents, in a lateral view of the pelvis, the method of extracting, by means of a curved crotchet, the head of the fœtus, when left in the uterus, after the body is delivered and separated from it; either by its being too large, or the pelvis too narrow.

ABC, the os sacrum and coccyx.

D, the os pubis of the left side.

EE, the uterus.

F, the locking part of the crotchet.

g, h, i, The point of the crotchet on the inside of the cranium.

Fig. 32. represents the forceps and blunt hook.

A, the straight forceps, in the exact proportion as to the width between the blades, and length from the points to the locking part; the first being two and the second six inches, which, with three inches and a half (the length of the handles), make in all 11 inches and a half.

B represents the posterior part of a single blade, in order to show the width and length of the open part of the same, and the form and dimensions of the whole.

C, the blunt hook, which is used for three purposes: 1. To assist the extraction of the head, after the cranium is opened with the scissors, by introducing the small end along the ear on the outside of the head to above the under-jaw, where the point is to be fixed; the other extremity of the hook being held with one hand, whilst two fingers of the other are to be introduced into the fore-said opening, by which hold the head is to be gradually extracted. 2. The small end

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is useful in abortion, in any of the first four or five months, to hook down the secundines, when lying loose in the uterus, when they cannot be extracted by the fingers or labour-pains, and when the patient is much weakened by floodings. 3. The large hook at the other end is useful to assist the extraction of the body, when the breech presents; but should be used with great caution, to avoid the dislocation or fracture of the thigh.

Fig. 33. A represents the whale-bone fillet, which may be sometimes useful in laborious cases, when the operator is not provided with the forceps, in sudden and unexpected exigencies.

BB, two views of a pessary for the prolapsus uteri. After the uterus is reduced, the large end of the pessary is to be introduced into the vagina, and the os uteri retained in the concave part, where there are three holes to prevent the stagnation of any moisture. The small end without the os externum has two tapes drawn through the two holes, which are tied to four other tapes, that hang down from a belt that surrounds the woman's body, and by this means keep up the pessary. This pessary may be taken out by the patient when she goes to bed, and introduced again in the morning; but as this sometimes rubs the os externum, so as to make its use uneasy, the round kind, marked C, are of more general use. They are made of wood, ivory, or cork, (the last covered with cloth and dipped in wax): the pessary is to be lubricated with pomatum, the edge forced through the passage into the vagina, and a finger introduced in the hole in the middle lays it across within the os externum. They ought to be larger or smaller, according to the wideness or narrowness of the passage, to prevent their being forced out by any extraordinary straining.

DD gives two views of a female catheter, to show its degree of curvature and different parts.

Fig. 34. *a*, represents a pair of curved crotchets locked together in the same manner as the forceps. The dotted lines along the inside of one of the blades represent a sheath contrived to guard the point till it is introduced high enough: the ligature at the handles marked with two dotted lines is then to be untied, the sheath withdrawn, and the point being uncovered is fixed as in fig. 21. (Pl. cccviii.)

b, Gives a view of the back-part of one of the crotchets, which is 12 inches long.

c, A front view of the point, to show its proportional length and breadth.

d, The scissors for perforating the cranium in very narrow and distorted pelvises. They ought to be made very strong, and at least nine inches in length, with stops or rests in the middle of the blades, by which a large dilatation is more easily made.

Plate CCCX. fig. 35. gives an anterior view of the improved lever by Roonhuijsen, an instrument now come into considerable reputation. Fig. 36. shows the same in profile. Fig. 37. the lever recommended

by M. Baudelocque. Fig. 38. one of the blades of a lever recommended by M. Herbinaux, fixed in the handle. Fig. 39. an anterior view of the same blade with the strap. Fig. 40. the spout of the syringe, when the instrument is used for injecting oil, or any other liquid into the uterus. The following is a general description of Roonhuijsen's lever, with the method of using it, as given by M. Preville, and added to his edition of Smellie's Midwifery. "The lever is an oblong piece of iron, 11 inches long, one broad, and about an eighth of an inch in thickness, it is straight in its middle for four inches, and becomes gradually curved at each extremity: the curves are of different lengths and depths; the edges are rounded; and the extremities for the space of an inch, and also the middle of the instrument, are directed to be covered with plaster, and then the whole of it to be sheathed with thin dogskin; taking care to avoid inequalities or folds, which might injure the woman or child. In using it, the accoucheur must introduce the fore-finger of his left hand into the vagina near the anus, to serve as a guide for the instrument, which must now be gently insinuated between his finger and the head of the child, taking care that no part of the uterus be included between the lever and the head. The instrument must then be moved to the right and to the left, to find where there is the greatest space, and in some degree to loosen and disengage the head; and then gradually carried round, until it comes under the pubes, lifting the end of it from time to time, to obtain a freer passage. The handle of it must now be raised, and the instrument gently shifted about, until the occiput is exactly lodged in its curve. The more completely and exactly the curve touches and embraces the head, the more speedily and easily the delivery will be effected. The instrument being thus firmly and equally applied to the head, the accoucheur must slowly and uniformly raise the handle with his right hand, while with his left he presses the middle of it downward; by this means the coccyx is forced backward, and the lower part of the pelvis is enlarged. By continuing to raise the handle of the lever and to press down its middle or centre, the head of the child is made to descend into the dilated cavity of the vagina: and this is commonly effected in a few minutes; when the left hand must be applied firmly against the anus and perinæum, forcing those parts upwards and forwards towards the orifice of the vagina, to prevent laceration; for which purpose also the whole operation must be performed slowly and cautiously, imitating as much as possible a natural labour."

"We found (add the authors of the paper,) a cord fixed round one of the ends of the instrument, about the middle of the curve. This cord, we imagine, served no other purpose than to point out the end of the instrument commonly made use of, or to measure the length of the part introduced."

INSTRUCTIONS FOR READING THE PLATES OF VOL. XI.

PLATE I.		PLATE II.	
Fig. 1.	CCXII	Fig. 1.	CCXII
Fig. 2.	CCXIII	Fig. 2.	CCXIII
Fig. 3.	CCXIV	Fig. 3.	CCXIV
Fig. 4.	CCXV	Fig. 4.	CCXV
Fig. 5.	CCXVI	Fig. 5.	CCXVI
Fig. 6.	CCXVII	Fig. 6.	CCXVII
Fig. 7.	CCXVIII	Fig. 7.	CCXVIII
Fig. 8.	CCXIX	Fig. 8.	CCXIX
Fig. 9.	CCXX	Fig. 9.	CCXX
Fig. 10.	CCXXI	Fig. 10.	CCXXI
Fig. 11.	CCXXII	Fig. 11.	CCXXII
Fig. 12.	CCXXIII	Fig. 12.	CCXXIII
Fig. 13.	CCXXIV	Fig. 13.	CCXXIV
Fig. 14.	CCXXV	Fig. 14.	CCXXV
Fig. 15.	CCXXVI	Fig. 15.	CCXXVI
Fig. 16.	CCXXVII	Fig. 16.	CCXXVII
Fig. 17.	CCXXVIII	Fig. 17.	CCXXVIII
Fig. 18.	CCXXIX	Fig. 18.	CCXXIX
Fig. 19.	CCXXX	Fig. 19.	CCXXX
Fig. 20.	CCXXXI	Fig. 20.	CCXXXI
Fig. 21.	CCXXXII	Fig. 21.	CCXXXII
Fig. 22.	CCXXXIII	Fig. 22.	CCXXXIII
Fig. 23.	CCXXXIV	Fig. 23.	CCXXXIV
Fig. 24.	CCXXXV	Fig. 24.	CCXXXV
Fig. 25.	CCXXXVI	Fig. 25.	CCXXXVI
Fig. 26.	CCXXXVII	Fig. 26.	CCXXXVII
Fig. 27.	CCXXXVIII	Fig. 27.	CCXXXVIII
Fig. 28.	CCXXXIX	Fig. 28.	CCXXXIX
Fig. 29.	CCXL	Fig. 29.	CCXL
Fig. 30.	CCXLI	Fig. 30.	CCXLI
Fig. 31.	CCXLII	Fig. 31.	CCXLII
Fig. 32.	CCXLIII	Fig. 32.	CCXLIII
Fig. 33.	CCXLIV	Fig. 33.	CCXLIV
Fig. 34.	CCXLV	Fig. 34.	CCXLV
Fig. 35.	CCXLVI	Fig. 35.	CCXLVI
Fig. 36.	CCXLVII	Fig. 36.	CCXLVII
Fig. 37.	CCXLVIII	Fig. 37.	CCXLVIII
Fig. 38.	CCXLIX	Fig. 38.	CCXLIX
Fig. 39.	CCCL	Fig. 39.	CCCL
Fig. 40.	CCCLI	Fig. 40.	CCCLI
Fig. 41.	CCCLII	Fig. 41.	CCCLII
Fig. 42.	CCCLIII	Fig. 42.	CCCLIII
Fig. 43.	CCCLIV	Fig. 43.	CCCLIV
Fig. 44.	CCCLV	Fig. 44.	CCCLV
Fig. 45.	CCCLVI	Fig. 45.	CCCLVI
Fig. 46.	CCCLVII	Fig. 46.	CCCLVII
Fig. 47.	CCCLVIII	Fig. 47.	CCCLVIII
Fig. 48.	CCCLIX	Fig. 48.	CCCLIX
Fig. 49.	CCCLX	Fig. 49.	CCCLX
Fig. 50.	CCCLXI	Fig. 50.	CCCLXI
Fig. 51.	CCCLXII	Fig. 51.	CCCLXII
Fig. 52.	CCCLXIII	Fig. 52.	CCCLXIII
Fig. 53.	CCCLXIV	Fig. 53.	CCCLXIV
Fig. 54.	CCCLXV	Fig. 54.	CCCLXV
Fig. 55.	CCCLXVI	Fig. 55.	CCCLXVI
Fig. 56.	CCCLXVII	Fig. 56.	CCCLXVII
Fig. 57.	CCCLXVIII	Fig. 57.	CCCLXVIII
Fig. 58.	CCCLXIX	Fig. 58.	CCCLXIX
Fig. 59.	CCCLXX	Fig. 59.	CCCLXX
Fig. 60.	CCCLXXI	Fig. 60.	CCCLXXI
Fig. 61.	CCCLXXII	Fig. 61.	CCCLXXII
Fig. 62.	CCCLXXIII	Fig. 62.	CCCLXXIII
Fig. 63.	CCCLXXIV	Fig. 63.	CCCLXXIV
Fig. 64.	CCCLXXV	Fig. 64.	CCCLXXV
Fig. 65.	CCCLXXVI	Fig. 65.	CCCLXXVI
Fig. 66.	CCCLXXVII	Fig. 66.	CCCLXXVII
Fig. 67.	CCCLXXVIII	Fig. 67.	CCCLXXVIII
Fig. 68.	CCCLXXIX	Fig. 68.	CCCLXXIX
Fig. 69.	CCCLXXX	Fig. 69.	CCCLXXX
Fig. 70.	CCCLXXXI	Fig. 70.	CCCLXXXI
Fig. 71.	CCCLXXXII	Fig. 71.	CCCLXXXII
Fig. 72.	CCCLXXXIII	Fig. 72.	CCCLXXXIII
Fig. 73.	CCCLXXXIV	Fig. 73.	CCCLXXXIV
Fig. 74.	CCCLXXXV	Fig. 74.	CCCLXXXV
Fig. 75.	CCCLXXXVI	Fig. 75.	CCCLXXXVI
Fig. 76.	CCCLXXXVII	Fig. 76.	CCCLXXXVII
Fig. 77.	CCCLXXXVIII	Fig. 77.	CCCLXXXVIII
Fig. 78.	CCCLXXXIX	Fig. 78.	CCCLXXXIX
Fig. 79.	CCCLXXX	Fig. 79.	CCCLXXX
Fig. 80.	CCCLXXXI	Fig. 80.	CCCLXXXI
Fig. 81.	CCCLXXXII	Fig. 81.	CCCLXXXII
Fig. 82.	CCCLXXXIII	Fig. 82.	CCCLXXXIII
Fig. 83.	CCCLXXXIV	Fig. 83.	CCCLXXXIV
Fig. 84.	CCCLXXXV	Fig. 84.	CCCLXXXV
Fig. 85.	CCCLXXXVI	Fig. 85.	CCCLXXXVI
Fig. 86.	CCCLXXXVII	Fig. 86.	CCCLXXXVII
Fig. 87.	CCCLXXXVIII	Fig. 87.	CCCLXXXVIII
Fig. 88.	CCCLXXXIX	Fig. 88.	CCCLXXXIX
Fig. 89.	CCCLXXX	Fig. 89.	CCCLXXX
Fig. 90.	CCCLXXXI	Fig. 90.	CCCLXXXI
Fig. 91.	CCCLXXXII	Fig. 91.	CCCLXXXII
Fig. 92.	CCCLXXXIII	Fig. 92.	CCCLXXXIII
Fig. 93.	CCCLXXXIV	Fig. 93.	CCCLXXXIV
Fig. 94.	CCCLXXXV	Fig. 94.	CCCLXXXV
Fig. 95.	CCCLXXXVI	Fig. 95.	CCCLXXXVI
Fig. 96.	CCCLXXXVII	Fig. 96.	CCCLXXXVII
Fig. 97.	CCCLXXXVIII	Fig. 97.	CCCLXXXVIII
Fig. 98.	CCCLXXXIX	Fig. 98.	CCCLXXXIX
Fig. 99.	CCCLXXX	Fig. 99.	CCCLXXX
Fig. 100.	CCCLXXXI	Fig. 100.	CCCLXXXI

E. B. A. D. M.

IN THE NATIONAL ANTHROPOLOGICAL ARCHIVES

DIRECTIONS FOR PLACING THE PLATES OF VOL. XI.

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CCXCII. }	-	45	CCC.	-	720
CCXCIII. }	-		CCCI.	-	724
CCXCIV.	-	365	CCCII.	-	749
			CCCIII.	-	753
			CCCIV.	-	756
PART II.					
CCXCV.	-	693	CCCV.	-	757
CCXCVI.	-	704	CCCVI.	-	808
CCXCVII.	-	709	CCCVII.	-	809
CCXCVIII.	-	713	CCCVIII.	-	810
CCXCIX.	-	716	CCCIX. }	-	814
			CCCX. }	-	

E R R A T U M.

In Vol. VIII. col. 2. marg. note 66. For *inferiority*, read *superiority*.

Fig. 24.

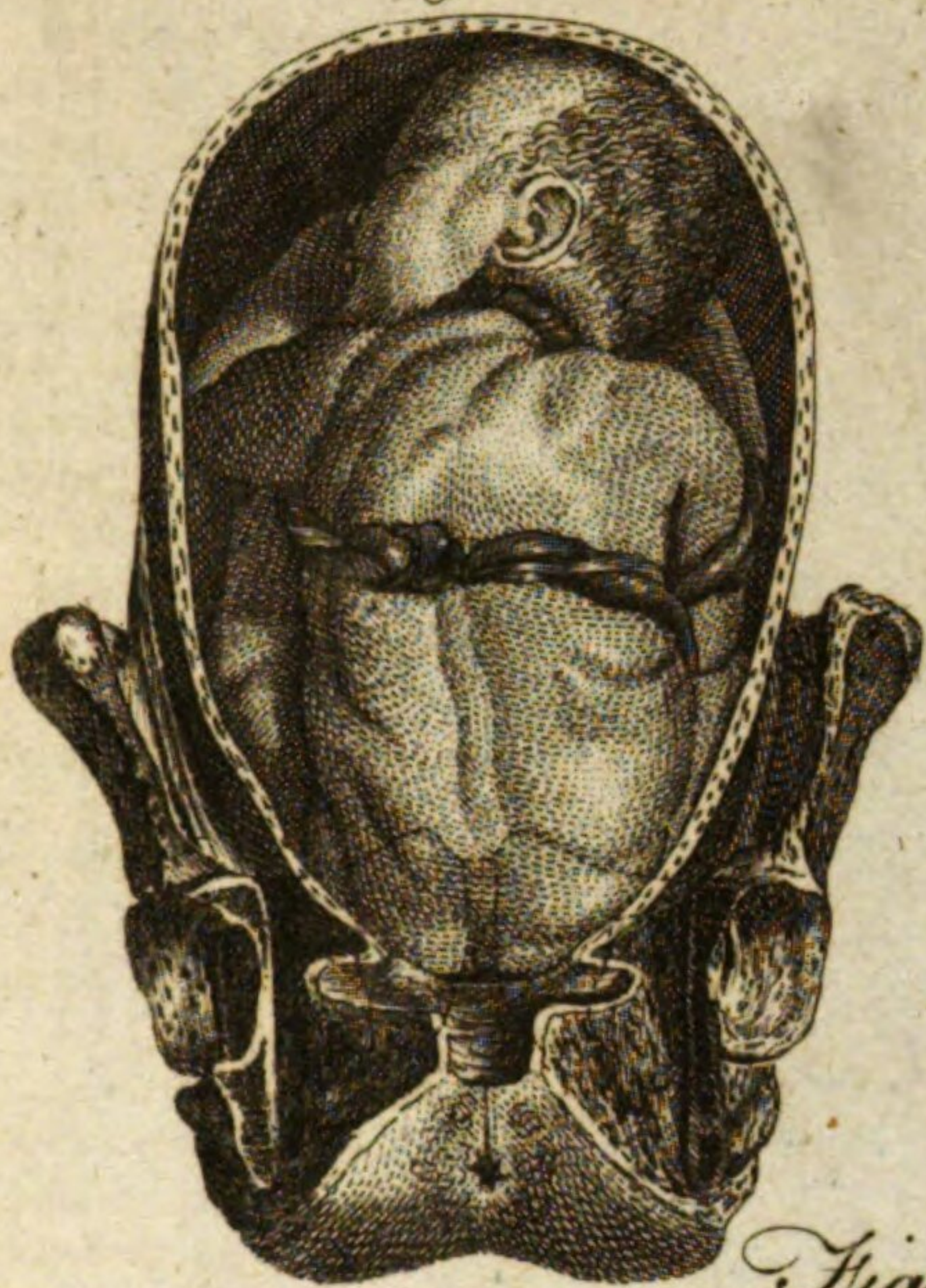


Fig. 25.



Fig. 32.

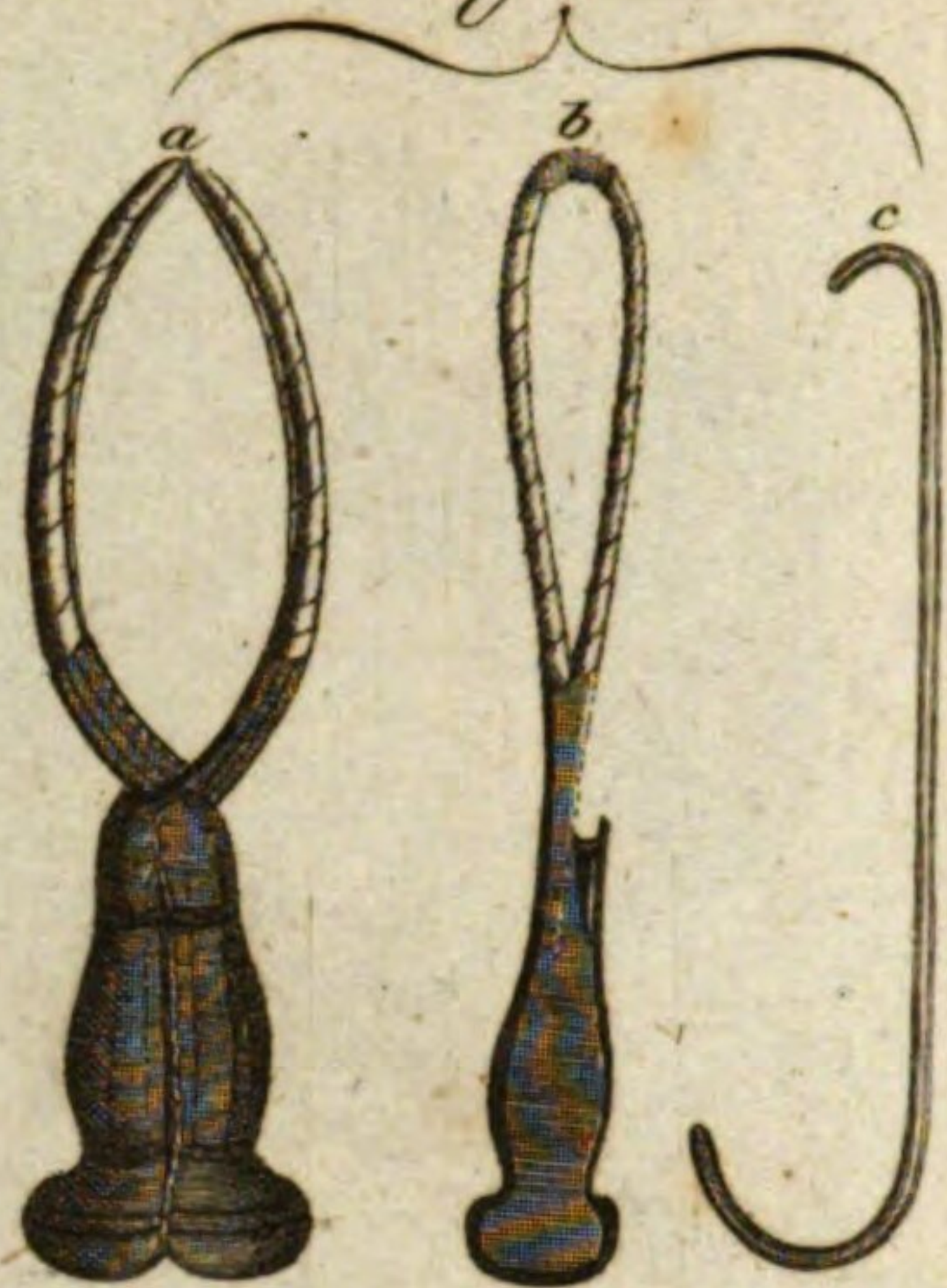


Fig. 26.

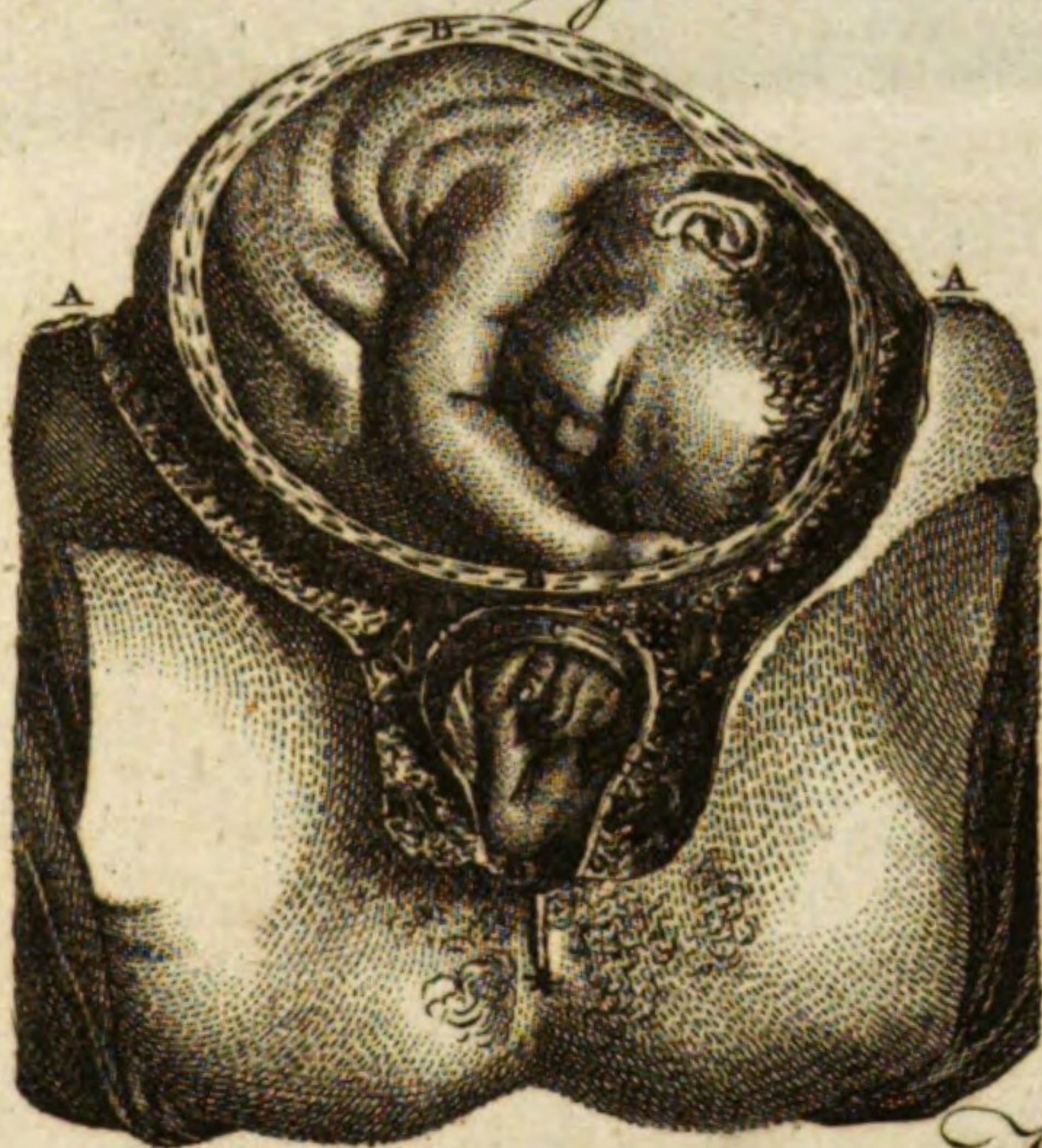


Fig. 33.

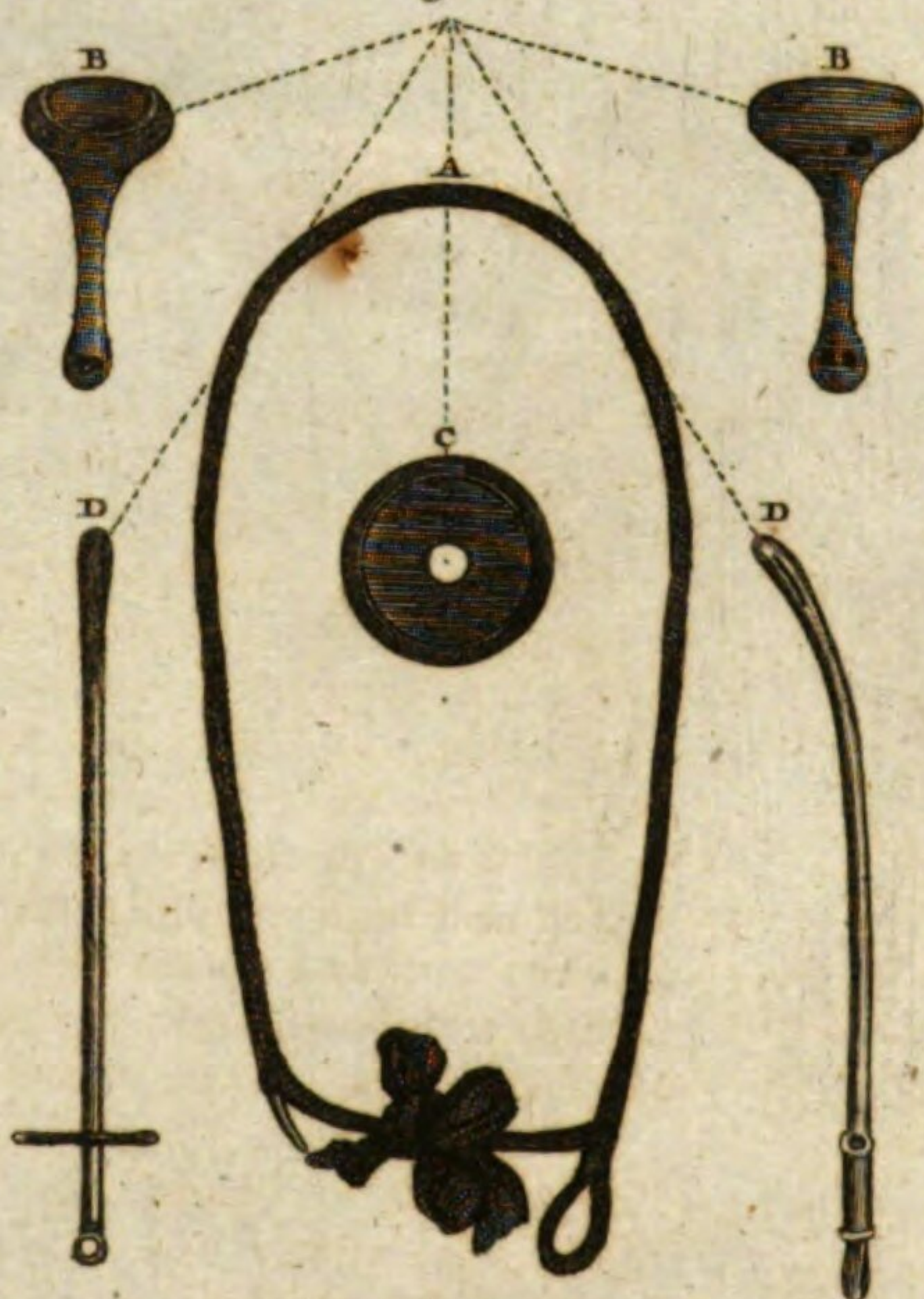


Fig. 27.

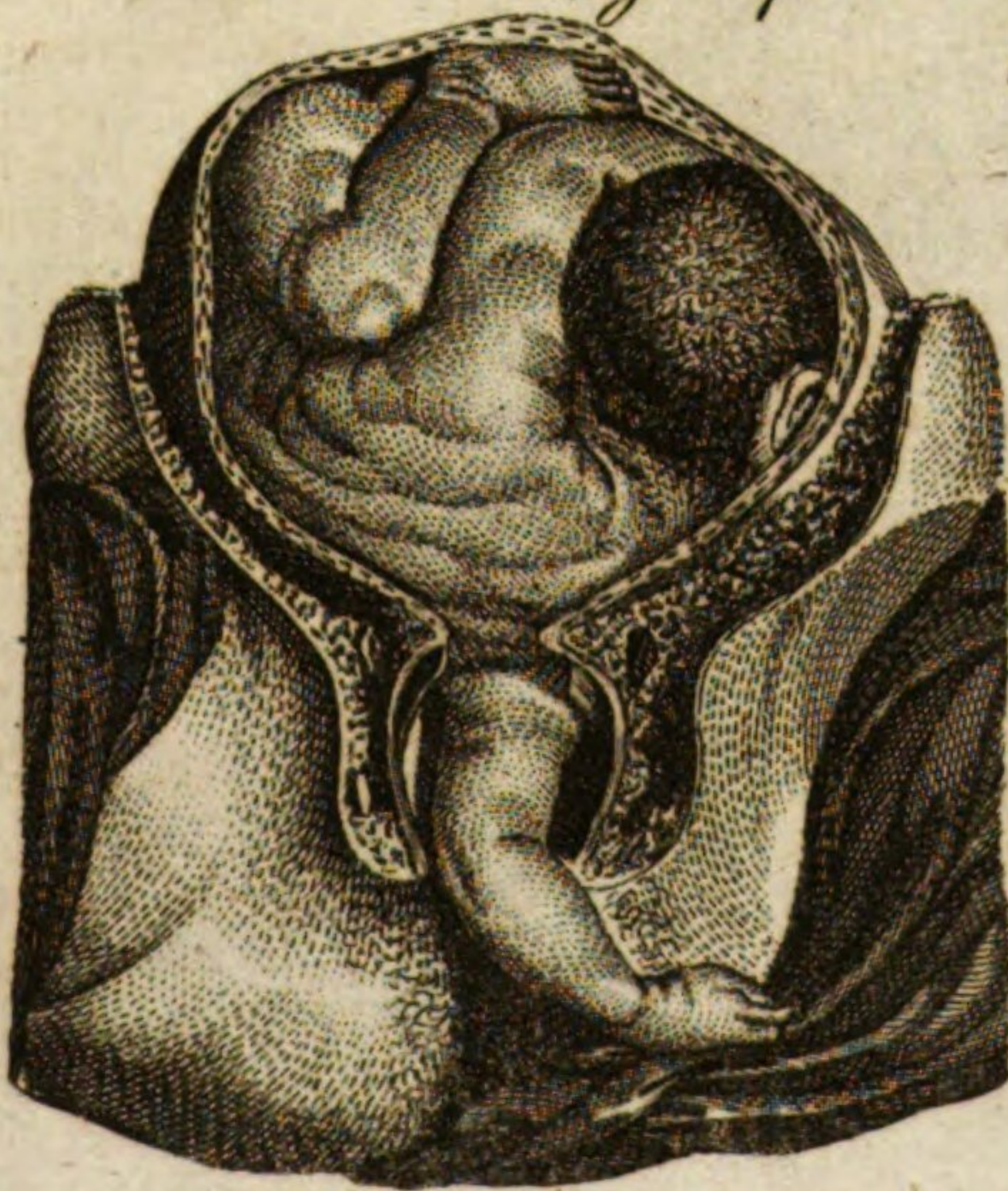


Fig. 28.



Fig. 34.

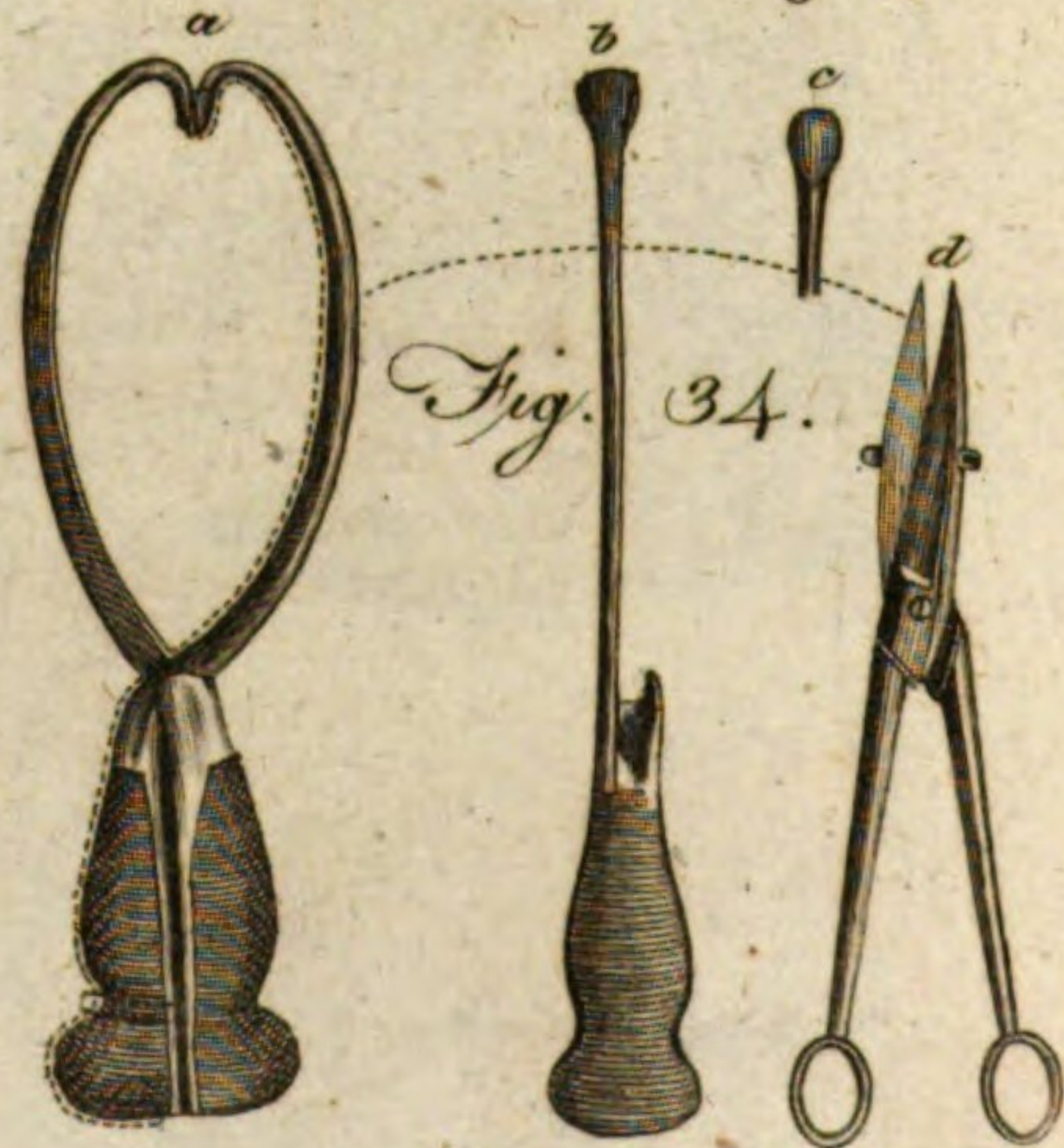


Fig. 35



Fig. 36. Fig. 38.



Fig. 29.

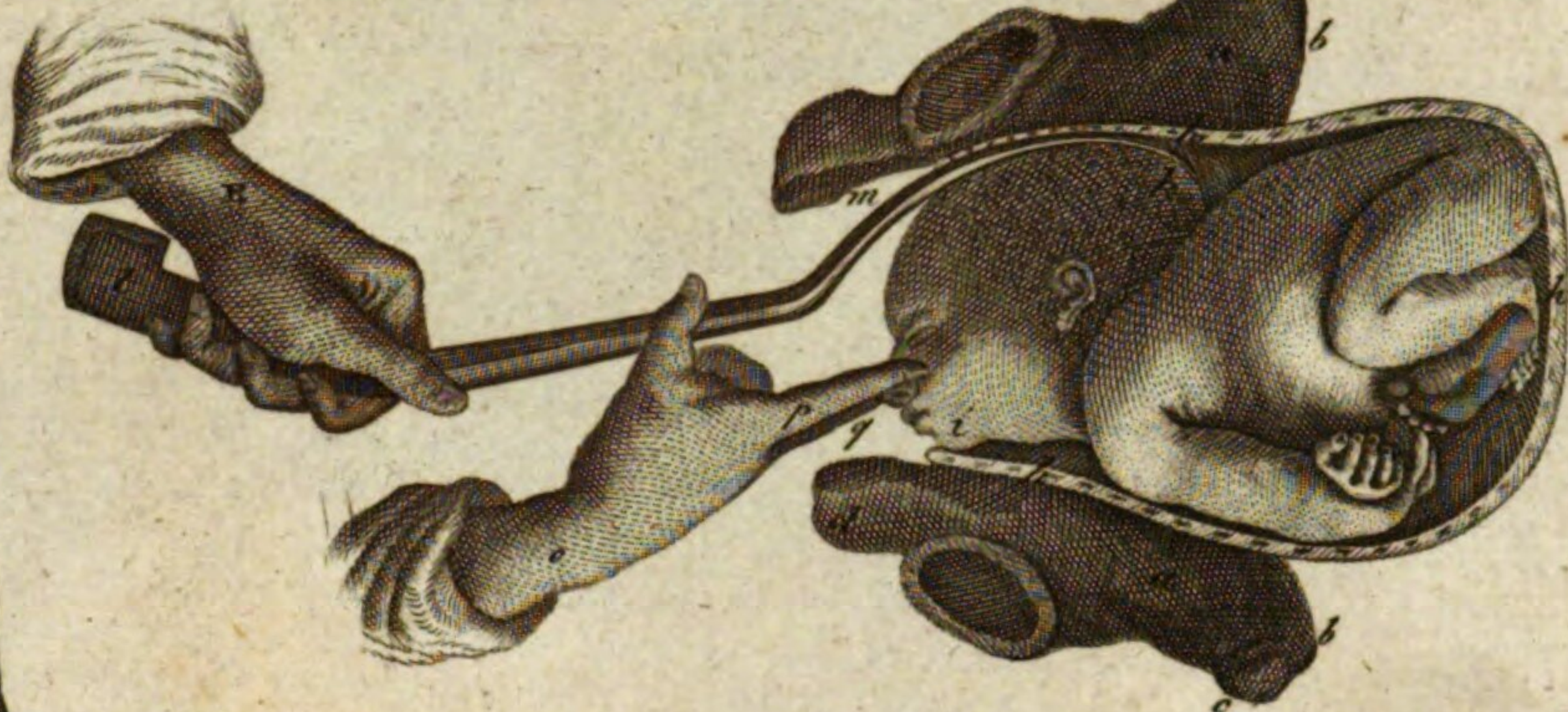


Fig. 30.

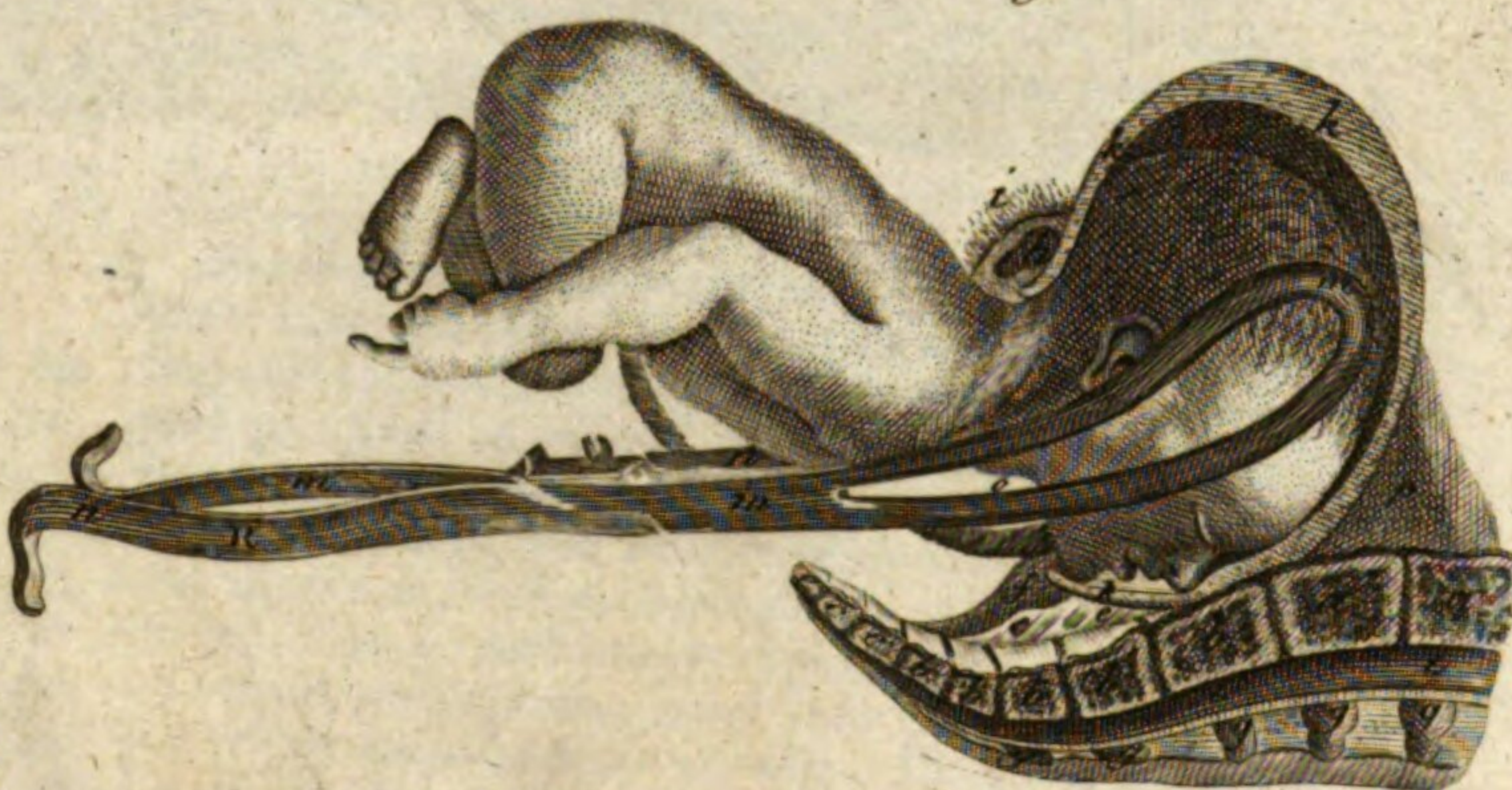


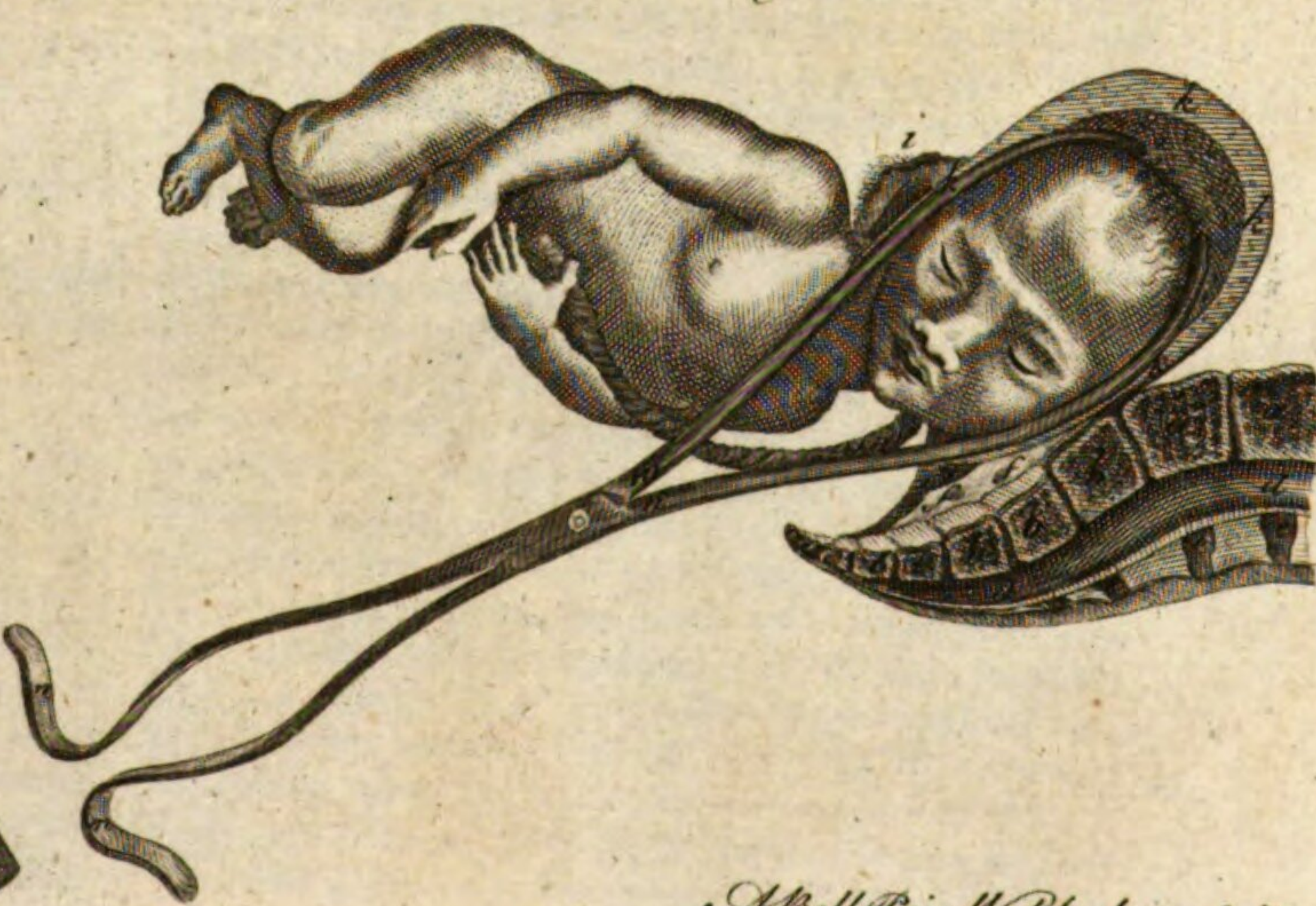
Fig. 37.



Fig. 39 Fig. 40.



Fig. 31.



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castle. Before the south promontory of Man, is a little island called the *Calf of Man*: it is about three miles in circuit, and separated from Man by a channel about two furlongs broad. At one time of the year it abounds with puffins, and also with a species of ducks and drakes, by the English called *barnacles*, and by the Scots *clakes* and *Soland geese*.

The inhabitants of this isle are of the church of England; and the bishop is styled *Bishop of Sodor and Man*. This bishopric was first erected by Pope Gregory IV. and for its diocese had this isle and all the Hebrides, or Western islands of Scotland; but which were called *Sodoroc* by the Danes, who went to them by the north, from the Swedish Sodor, Sail or Oar islands, from which the title of the bishop of Sodor is supposed to originate. The bishop's seat was at Rushin, or castletown, in the isle of Man, and in Latin is entitled *Sodorensis*. But when this island became dependent upon the kingdom of England, the Western islands withdrew themselves from the obedience of their bishop, and had a bishop of their own, whom they entitled also *Sodorensis*, but commonly *Bishop of the Isles*. The patronage of the bishopric was given, together with the island, to the Stanleys by king Edward IV. and came by an heir-female to the family of Athole; and, on a vacancy thereof, they nominated their designed bishop to the king, who dismissed him to the archbishop of York for consecration.—By an act of parliament, the 33d of King Henry VIII. this bishopric is declared in the province of York.

MAN-of-war Bird. See PELICANUS.

MANAGE. See MANEGE.

MANASSEH (in Scripture hist.), the eldest son of Joseph, and grandson of the patriarch Jacob (Gen. xli. 50, 51.) was born in the year of the world 2290, before Jesus Christ 1714.

The tribe descended from him came out of Egypt, in number 32,200 men, fit for battle, upwards of 20 years old, under the conduct of Gamaliel son of Pedahzur (Numb. ii. 20, 21.) This tribe was divided at their entrance into the land of Promise. One half had its portion beyond the river Jordan, and the other half on this side the river. The half tribe of Manasseh which settled beyond the river possessed the country of Bashan, from the river Jabbok to mount Libanus, (Numb. xxii. 33, 34. &c.); and the other half tribe of Manasseh on this side Jordan, obtained for its inheritance the country between the tribe of Ephraim to the south and the tribe of Issachar to the north, having the river Jordan to the east and the Mediterranean sea to the west, (Josh. xvi. xvii.)

MANASSEH, the 15th king of Judah, being the son and successor of Hezekiah. His acts are recorded in 2 Kings xx. xxi. and 2 Chr. xxxiii.

MANATI, in zoology. See TRICHECUS.

MANCA, was a square piece of gold coin, commonly valued at 30 pence; and *mancusa* was as much as a mark of silver, having its name from *manu cusa*, being coined with the hand: (*Leg. Canut.*) But the *manca* and *mancusa* were not always of that value; for sometimes the former was valued at six shillings, and the latter, as used by the English Saxons, was equal in value to our half-crown. *Manca sex solidis aestimetur*, (*Leg. H. I. c. 69.*) Thorn in his chronicle, tells us, that *mancusa est pondus duorum solidorum et sex dena-*
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riorum; and with him agrees Du Cange, who says, that 20 *manca* make 50 shillings. *Manca* and *mancusa* are promiscuously used in the old books for the same money.

MANCHA, a territory of Spain in the province of New Castile, lying between the river Guadiana and Andalusia. It is a mountainous country; and it was here that the famous Don Quixote was supposed to perform his exploits.

MANCHESTER, a town of Lancashire in England, situated in W. Long. 2. 42. N. Lat. 53. 27. Mr Whitaker conjectures, that the station was first occupied by the Britons about 500 years B. C. but that it did not receive any thing like the form of a town till 450 years after, or 50 years B. C. when the Britons of Cheshire made an irruption into the territories of their southern neighbours, and of consequence alarmed the Seltuntii, or inhabitants of Lancashire, so much, that they began to build fortresses, in order to defend their country. Its British name was *Man-cenion*, that is, "a place of tents:" it was changed, however, into *Mancunium* by the Romans, who conquered it under Agricola in the memorable year of the Christian era 79. It appears also to have been called *Manduesfedum*, *Mandueffedum*, *Manucium*, and *Mam-cestre*; from which last it seems most evident that the present name has been derived. It is distant from London 182 miles, and from Edinburgh 214; standing near the conflux of the Irk and the Irwell, about three miles from the Mersey.

Manchester was accounted a large and populous town even 50 years ago; but since that time it is supposed to have increased in more than a triple proportion, both in respect to buildings and inhabitants. The houses amount to a number not far short of 12,000; and perhaps it may not be an over-rate to reckon seven persons to each, when it is considered, that, of the houses occupied by working people of various descriptions, many have two, three, and sometimes more, families in each. For though many hundred houses have been built in the course of a few late years, yet are they constantly engaged as soon as possible; the avidity for building increasing with every new accession of inhabitants, and rents rising to a degree scarcely known in other places. The progress of this *οικομανια* may be partly estimated by the price of building, land, and materials: a guinea per square yard, chief rent, having been refused for some central plots; and bricks selling at 24s. per 1000, which about four years since were not more than half the price. Such, however, has been the happy concurrence of ingenuity and industry, and such the astonishing improvements daily making in its numerous manufactures, together with the encouragement these afford to skilful artists in various branches, that streets must extend in proportion: yet population appears to have increased more rapidly than buildings; hence competitions naturally arise, and hence a temporary advance of rents. The manufactures of this town and neighbourhood, from humble domestic beginnings about two centuries ago, have now, after progressive improvements, acquired such celebrity, both in the scale of ornament and utility, as to spread in ten thousand forms and colours, not only in these kingdoms, but over all Europe, and even into the distant continents; being at

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once most precious mines of well-earned private wealth, and important contributors to the necessary public treasure of the state. Its post-office alone may afford an evidence of its extensive commerce. The population of the town may be further calculated from the great number of cotton factories within the boundaries of the town, wherein it is thought that 20,000 men, women, and children, are employed in the mere branches of preparing *warp* and *weft*. If to these be added the many hands applied to weaving, &c. &c. &c. beside all the more general mechanics, as well as householders, domestic servants, &c. Manchester may be ranked as the most populous market-town in Great Britain. The marriages in Manchester and Salford, from January 1791 to January 1792, were 1302, the christenings 2960, and the burials 2286. Hence, should it be computed that one in every 30 persons died, the number of inhabitants would amount to 68,580, which is thought to be much under the sum of an actual enumeration. The streets are about 600, many of them spacious and airy, great part of the old buildings being removed, and the new streets allowed a convenient breadth. The town is now lighted every night by 2000 lamps, and guarded by nearly 200 watchmen.

The college here was founded in 1422 by *Thomas West* Lord Delaware; and consisted of a warden, eight fellows, four clerks, and six choristers. About the same time the present collegiate church was built (timber only having been used for the former church); and John Huntington bachelor of laws was the first warden, named by the founder himself: he enjoyed the wardenship nearly 40 years; and a monument justly remains to his memory, he having been the first to propose and assist in the erection of the church. He died Nov. 11. 1458, and was interred in the middle of the choir. This church is a fine structure of what is termed the Gothic system, and is more enriched with sculpture than such churches usually are. The tabernacle work over the stalls in the choir is very curious, as are the large arches added upon vaulting the choir. The organ, which cost not less than L.1000, is large and powerful. The last warden was Richard Murray, D. D. the 14th in succession. The college was new-founded in 1636; and Richard Heyrick, B. D. named the first warden on that foundation. The present warden, Richard Asheton, D. D. rector of Middleton, is the fifth in succession from Richard Heyrick. The collegiate body now consists of a warden, four fellows, two chaplains, two clerks (one of whom, by a very late regulation, is to be at least bachelor of arts and in priest's orders), four choristers, and four singing men.

Beside the collegiate church, there are also the following. St Anne's, a handsome church, begun in 1709 and finished in 1723: it is in the gift of the Bishop of Chester. St Mary's, built by the clergy of the collegiate church, and consecrated upwards of 30 years ago, is a neat and indeed an elegant edifice; as is St John's, which was built about 20 years since by the late Edward Byrom, Esq. The next presentation thereof is, by act of parliament, vested in his heirs, afterwards devolving to the warden and fellows of the collegiate church. St Paul's church was erected upwards of 12 years ago; and is a handsome spacious building, chiefly brick; to which has been added, within the last two

years, a lofty and substantial stone tower. St James's church has been finished within the last ten years: it is a large well-lighted building of brick and stone, with a small stone steeple. St Michael's is also of brick and stone, with a square tower. It was built by the late Rev. Humphrey Owen (one of the chaplains of the collegiate church, and rector of St Mary's), in whose heirs the presentation is vested for a term of 60 years, and thenceforward in the warden and fellows of the college. To these may be added, St Thomas's, Ardwick Green; and Trinity church, Salford: for though the Irwell intervenes between Manchester and Salford, and each is governed by its respective constables; yet, being connected by three bridges, by mutual friendship, and by the common pursuit of universally useful manufactures and commerce, the two places are generally considered under the name of *Manchester*, as the borough of Southwark is not improperly deemed a part of the metropolis. In Salford there is likewise a Methodist chapel nearly finished. A new church is also about to be built and dedicated to St Stephen. —In Manchester a new church is lately finished, and called *St George's*; but divine service has not yet been performed therein. St Peter's church, at the end of Mosley-street, was begun about three years since: when finished, it will be a strong and elegant stone structure with a high spire; at present the body only is completed, and lighted, in a manner not very common, by six semicircular windows. The foundation of another church, to be called *St Clement's*, has also been laid, within the present year 1792, in Stephenson's square lately planned; and also one called the *New Jerusalem Church*, nearly finished. Beside the 14 churches above enumerated, there are, a Catholic chapel, a large Methodist chapel, a chapel for the people called Quakers, and 5 chapels for dissenters of other denominations.

Cheetham's Hospital, commonly called the College, because it was originally the place of residence of the warden and fellows, is deserving of particular notice. Humphrey Cheetham of Clayton near Manchester, Esq; having been remarkably successful in trade in the middle of the last century, bought the college, and liberally endowed it for the maintenance and education of 40 poor boys, admissible between the age of 6 and 10 years. By an improvement of the funds of the charity, the numbers of boys was increased to 60; and continued such till the Easter meeting of the feoffees in 1780, when another augmentation took place, and the number has since been constantly 80. The townships, pointed out by the founder for objects of his charity, are the following, together with the respective numbers admitted from each: Manchester, original number 14, now 28; Salford 6, now 12; Droylsden 3, now 6; Crumpsall 2, now 4; Bolton-le-moors 10, now 20; Turton 5, now 10. So that 89 persons are now annually provided for by this liberal benefactor; including for the hospital a governor, 1 man and 5 women servants; a school-master; and, on the library establishment, a librarian. (See an authentic letter in the *Gent. Mag.* for June 1792, p. 521.) The boys of this hospital are comfortably provided for till the age of 14, when they are further clothed, and with a premium placed apprentices to useful trades; and, in order to incite early

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early habits of industry, to make them good servants, and at length good masters, it has been suggested to furnish some kind of easy employment for a small part of their time not engaged at school. The Library, which occupies an extensive gallery of the same building, owes its foundation and increasing importance to the same benevolent source. The annual value of the fund originally bequeathed for the purchase of books and for a librarian's salary was 116l.; but, by recent improvements of the estate, the income is more than thrice that sum. The books at this time amount to 10,000 volumes, of which a catalogue handsomely printed in 2 volumes 8vo has been published by the present librarian, the Rev. John Radcliffe, A. M. At stated hours, on all days, except Sundays and other holidays, the studious may have free access to read, in the library, any book it contains; and in order to render it comfortable during the cold season of the year, several stoves are kept heated at the reading hours. This college and a large inclosed area are situated upon a high perpendicular rock, bounded by the Irk close to its confluence with the Irwell; and is thought by Mr Whitaker to be included, as well as the collegiate church, within the boundaries of the ancient Roman prætorium; the whole of which site towards the Irwell, as on the side of the Irk, is considerably elevated above the water and the opposite land of Salford. The Free-school, higher up on the same side the Irk, almost joining to the college, is supported by the rents of three mills; one of which is for grinding malt; another for corn, and the third is employed as a snuff-mill. These rents are now increased to 700l. per annum, from which salaries are paid to three masters and two assistants. The scholars educated here have certain exhibitions allowed at the university; and such of them as are entered at Brazen-nose college Oxford have a chance of obtaining some valuable exhibitions arising from lands in Manchester bequeathed by Mr Hulme. The deserved reputation of this school is a powerful recommendation of its scholars entering at the universities. The Academy is a large and commodious building, raised by the subscriptions of several respectable dissenters, and placed under the care of able tutors. Here youth above 14 years of age are admitted and instructed in the various branches of liberal knowledge, preparatory to trade or the professions. The Literary and Philosophical Society of Manchester was instituted in the beginning of the year 1781, and is well known by its Memoirs, of which three volumes 8vo have been published; these have been translated into the German language. A fourth volume is now in the press, and in all probability will be published in the spring of 1793. A society was established here in November 1789, under the name of the *Lancashire Humane Society*, for the encouragement of all who may attempt the recovery of persons apparently drowned. The Infirmary, Dispensary, Lunatic Asylum, and public Baths, are all situated on one large airy plot of land, in the most elevated and agreeable part of the town; a pleasant grass-plot and gravel-walk extending the whole length of the buildings; a canal intervening between them and the public street, next to which it is guarded by iron palisades. The Lying-in-hospital is situated in Salford, at the end of the old bridge. A new Work-house is nearly completed; and

for such a purpose a happier spot could not be found in any town than that whereon it is erected, being on an equal eminence with the college on the opposite side of the Irk, and promising the greatest possible comforts to such as may be necessitated to become its inhabitants. The Exchange was a strong good building; but since the late act of parliament obtained for farther improvements of the town, it has been sold and taken down, and its site formed into a convenient area, to the great advantage of the surrounding houses. The Theatre is a neat building, wherein the boxes are placed in a semicircle opposite to the stage. The Gentlemen's Concert-room is an elegant building, capacious enough to accommodate 1200 persons. The concerts are supported by annual subscriptions: but strangers and military gentlemen have free admission to the private concerts; as also to the public concerts, with a subscriber's ticket. The new Assembly-rooms are large and commodious. A Circus is almost finished. Here are two Market-places, the old and the new; which are well supplied with every thing in season, though at high rates. There are several charity schools belonging to different churches and chapels, where children are furnished with clothes and taught to read. The Sunday-schools are numerous, and afford instruction to upwards of 5000 children.

Over the Irwell are three bridges, uniting the town with Salford: the old bridge is very high at the Manchester end, whence it slopes into Salford. The middle bridge, four feet wide, raised upon timber and flagged, is only for accommodation of foot-passengers, who from the Manchester side must descend to it by nearly forty steps. The lower bridge is a handsome stone building of two arches; this bridge affords a level road for two or three carriages abreast. It was undertaken and finished by the private subscription of a few gentlemen; and a small toll is taken for all passing, which toll is now annually let by auction, and pays the proprietors remarkably well.—From Manchester there are likewise the same number of bridges over the Irk; only one, however, is adapted for the passage of carriages. The Irwell, having at a great expence been rendered navigable for vessels of 20 or 30 tons burden, there is a constant communication between Liverpool, Manchester, and the intermediate places on the Irwell and Mersey, to the great advantage of the proprietors and the country at large. This navigation, and more especially the duke of Bridgewater's canal, opening a passage from Manchester to the Mersey at 30 miles distance, have, together, greatly contributed to the present highly flourishing state of the town. Advantages still greater, because more widely diffusive, may result from the intended union of the Humber and the Mersey by means of canals. Indeed, every mile of canal would benefit many miles of land; and such would be the reciprocity of interest, that it would undoubtedly extend and be felt far beyond the visible measurement of the navigation.

We must not omit to notice the new penitentiary house, called the *New Bailey*, for separate confinement of various criminals. Over the entrance is a large session-room, with adjoining rooms for the magistrates, council, jurors, &c. Beyond this, in the centre of a very large area inclosed by very high walls,

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walls, stands the Prison, an extensive building, forming a cross three stories high; and the four wards of each story may in an instant be seen by any person in its centre. This prison is kept surprisingly neat and healthy; and such as can work at any trade, and are not confined for crimes of the greatest magnitude, are employed in a variety of branches; so that one may be seen beating and cleansing cotton, another carding it, another roving, and a fourth spinning. In the next place may be observed a man or a woman busy at the loom; and in another, one or more engaged in cutting and raising the velvet pile. Hence industry is not suffered to slumber in the solitary cell, nor to quit it under the acquired impressions of that torpor which formerly accompanied the emancipated prisoner from his dungeon; rendering him, perhaps, totally unfit for the duties of honest society, though well qualified, in all probability, to hord with gamblers, and be then, if not before, initiated into their pernicious mysteries.—At Kerfal-moor, three miles distant, horse-races are annually permitted. The banks of the rivers and various brooks about the town afford excellent situations for the numerous dye-houses employed for a multitude of fabrics. Among other things, the manufacture and finishing of hats is carried on to an extent of great importance.—The general market is here on Saturdays. Tuesday's market is chiefly for transacting business between the traders and manufacturers of the town and circumjacent country. The fairs are on Whit-Monday, October 1st, and November 17th.

Manchester is a manor with courts leet and baron. It sends no members to parliament, but gives title to a duke. The annual fall of rain is here about 42 inches; though from January 1791 to January 1792 it was 44 inches. The sun's greatest heat 1791 was 76°, July 17.

MANCHINEEL See HIPPOMANE.

MANCIPATIO, was a term made use of in the Roman law, and may be thus explained; every father had such a regal authority over his son, that before the son could be released from his subjection and made free, he must be three times over sold and bought, his natural father being the vender. The vendee was called *pater fiduciarius*. After this fictitious bargain, the *pater fiduciarius* sold him again to the natural father, who could then, but not till then, *manumit* or make him free. The imaginary sale was called *mancipatio*; and the act of giving liberty or setting him free after this was called *emancipatio*.

MANCIPATIO also signifies the selling or alienating of certain lands by the balance, or money paid by weight, and five witnesses. This mode of alienation took place only amongst Roman citizens, and that only in respect to certain estates situated in Italy, which were called *mancipia*.

MANCIPLE (*manceps*), a clerk of the kitchen, or caterer. An officer in the inner temple was anciently so called, who is now the steward there; of whom Chaucer, the ancient English poet, some time a student of that house, thus writes:

A manciple there was within the temple,
Of which all caterers might take ensample.

This officer still remains in colleges in the universities.

MANCUNIUM (anc. geog.), a town of the

Brigantes in Britain. Now *Manchester* in Lancashire. See MANCHESTER.

MANCUS (formed of *manu cusus*), in antiquity, an Anglo-Saxon gold coin, equal in value to 2½ solidi, or 30 pence; and in weight to 55 Troy grains. The first account of this coin that occurs in the history of our country, is about the close of the 8th century, in an embassy of Cenwulf king of Mercia to Leo III. requesting the restoration of the jurisdiction of the see of Canterbury: this embassy was enforced by a present of 120 mancuses. Ethelwolf also sent yearly to Rome 300 mancuses: and these coins are said to have continued in some form or other till towards the conclusion of the Saxon government. The heriots of the nobility are chiefly estimated by this standard in Canute's laws. It came originally from Italy, where it was called *ducat*: and is supposed to have been the same with the drachma or miliarenis current in the Byzantine empire.

MANDAMUS, in law, a writ that issues out of the court of king's-bench, sent to a corporation, commanding them to admit or restore a person to his office. This writ also lies where justices of the peace refuse to admit a person to take the oaths in order to qualify himself for enjoying any post or office; or where a bishop or archdeacon refuses to grant a probate of a will, to admit an executor to prove it, or to swear a church-warden, &c.

MANDANES, an Indian prince and philosopher, who for the renown of his wisdom was invited by the ambassadors of Alexander the Great to the banquet of the son of Jupiter. A reward was promised him if he obeyed, but he was threatened with punishment in case of a refusal. Unmoved by promises and threatenings, the philosopher dismissed them with observing, that though Alexander ruled over a great part of the universe, he was not the son of Jupiter; and that he gave himself no trouble about the presents of a man who possessed not wherewithal to content himself. "I despise his threats (added he): if I live, India is sufficient for my subsistence; and to me death has no terrors, for it will only be an exchange of old age and infirmity for the happiness of a better life."

MANDARINS, a name given to the magistrates and governors of provinces in China, who are chosen out of the most learned men, and whose government is always at a great distance from the place of their birth. *Mandarin* is also a name given by the Chinese to the learned language of the country; for besides the language peculiar to every province, there is one common to all the learned in the empire, which is in China what Latin is in Europe; this is called the *mandarin tongue*, or the *language of the court*.

MANDATE, in law, a judicial commandment to do something. See the article MANDAMUS.

MANDATE, in the canon law, a rescript of the pope commanding an ordinary collator to put the person therein named in possession of the first vacant benefice in his collation.

MANDATUM, was a fee or retainer given by the Romans to the *procuratores* and *advocati*. The *mandatum* was a necessary condition, without which they had not the liberty of pleading. Thus the legal eloquence of Rome, like that of our own country, could not be unlocked without a golden key.

MANDERSCHUIT, a town of Germany in the circle

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Encyclopaedia britannica or a dictionary of arts, sciences and
miscellaneous literature

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